Prepared for **Nevada Environmental Response Trust**

Project Number **21-37300A**

Prepared by **Ramboll Environ Emeryville, California**

Date **October 30, 2015**

ANNUAL REMEDIAL PERFORMANCE REPORT FOR CHROMIUM AND PERCHLORATE NEVADA ENVIRONMENTAL RESPONSE TRUST SITE HENDERSON, NEVADA

Annual Remedial Performance Report for Chromium and Perchlorate

Nevada Environmental Response Trust Site (Former Tronox LLC Site) Henderson, Nevada

Nevada Environmental Response Trust (NERT) Representative Certification

I certify that this document and all attachments submitted to the Division were prepared at the request of, or under the direction or supervision of NERT. Based on my own involvement and/or my inquiry of the person or persons who manage the system(s) or those directly responsible for gathering the information or preparing the document, or the immediate supervisor of such person(s), the information submitted and provided herein is, to the best of my knowledge and belief, true, accurate, and complete in all material respects.

Office of the Nevada Environmental Response Trust

Signature: Avis, not individually, but solely in its representative capacity as the
Nevada Environmental Response Trust Trustee
Signature: And Manuel Manuel and the Newsletter Contract of the Newsletter Contract of the Ne represent of conserved control of the Nevada Environmental Response Trust Trustee

Name: Jay A. Steinberg, not individually, but solely in his representative capacity as President of the Nevada Environmental Response Trust Trustee

Title: Solely as President and not individually

Company: Le Petomane XXVII, Inc., not individually, but solely in its representative capacity as the Nevada Environmental Response Trust Trustee

Date: $\frac{16}{99}/$

Annual Remedial Performance Report for Chromium and Perchlorate

Nevada Environmental Response Trust Site (Former Tronox LLC Site) Henderson, Nevada

Responsible Certified Environmental Manager (CEM) for this project

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and, to the best of my knowledge, comply with all applicable federal, state and local statutes, regulations and ordinances.

 $\frac{10/30/15}{\sqrt{10}}$

10/30/15

John M. Pekala, PG Date **Senior Manager**

Certified Environmental Manager Ramboll Environ US Corporation CEM Certificate Number: 2347 CEM Expiration Date: September 20, 2016

The following individuals provided input to this document:

John M. Pekala, PG Allan J. DeLorme, PE Christopher J. Ritchie, PE Christopher M. Stubbs, PhD, PE Alka Singhal, PhD

Jonathan Hunt, PhD Katie Linscott, MS Kate Logan, MPA Craig J. Knox Ruben So

> Date **October 30, 2015** Prepared by **Ramboll Environ** Description **Annual Remedial Performance Report For Chromium and Perchlorate**

Project No **21-37300A**

Ramboll Environ 2200 Powell Street Suite 700 Emeryville, CA 94608 USA T +1 510 655 7400 F +1 510 655 9517 www.ramboll-environ.com

CONTENTS

LIST OF TABLES

- Table 1 Interceptor Well Field Discharge Rates
- Table 2 Athens Road Well Field Discharge Rates
- Table 3 Seep Well Field Discharge Rates
- Table 4 Monthly Well Field Discharge Rates, July 2014 June 2015
- Table 5 Chromium Treatment Data for the GWTP, July 2014 June 2015
- Table 6 Weekly Chromium in FBR Influent and Effluent, July 2014 June 2015
- Table 7 Perchlorate Removed from the Environment
- Table 8 Weekly Perchlorate in FBR Influent and Effluent, July 2014 June 2015
- Table 9 Perchlorate Plume Mass Estimates
- Table 10 Chromium Plume Mass Estimates
- Table 11 Average Perchlorate Mass Loading in Las Vegas Wash
- Table 12 GW-11 Water Elevation, Water Volume, and Flow
- Table 13 GW-11 Analytical Monitoring
- Table 14 GW-11 Perchlorate Mass Estimate, July 2014 June 2015
- Table 15 GWETS Performance Metrics Summary

LIST OF FIGURES

- Figure 1a Well Location Map Groundwater Monitoring Program Wells
- Figure 1b Figure Location Map
- Figure 2a Hydrograph Pair Across the Barrier Wall M-69 and I-Y
- Figure 2b Hydrograph Pair Across the Barrier Wall M-70 and M-55
- Figure 2c Hydrograph Pair Across the Barrier Wall M-71 and M-56
- Figure 2d Hydrograph Pair Across the Barrier Wall M-72 and M-58
- Figure 2e Hydrograph Pair Across the Barrier Wall M-73 and M-67
- Figure 2f Hydrograph Pair Across the Barrier Wall M-74 and M-68
- Figure 3 Athens Road Well Field Drawdown
- Figure 4 Seep Well Field Drawdown
- Figure 5 Groundwater Extraction and Treatment System (GWETS) Flow Diagram
- Figure 6 Interceptor Well Field Total Chromium Concentrations
- Figure 7 Total Chromium Concentration Trends for Select Wells
- Figure 8 Athens Road Well Field Total Chromium Concentrations
- Figure 9 Perchlorate Removed from the Environment July 2014 June 2015
- Figure 10 Interceptor Well Field Perchlorate Concentrations
- Figure 11 Interceptor Well Field Perchlorate Concentration Trends for Select Wells
- Figure 12 Barrier Wall Well Line Perchlorate Concentrations
- Figure 13 Wells M-100 and M-23 Perchlorate Concentration vs. Groundwater Elevation **Trends**
- Figure 14 Athens Road Well Field Perchlorate Concentrations
- Figure 15 Athens Road Well Field Perchlorate Concentration Trends
- Figure 16 Athens Road Piezometer Well Line Perchlorate Concentrations
- Figure 17 Athens Road Piezometer Well Line Perchlorate Concentration Trends
- Figure 18 City of Henderson WRF Well Line Perchlorate Concentrations
- Figure 19 City of Henderson WRF Well Line Perchlorate Concentration Trends
- Figure 20 Well PC-98R Perchlorate Concentration vs. Water Elevation Trends
- Figure 21 Lower Ponds Well Line Perchlorate Concentrations
- Figure 22 Lower Ponds Well Line Perchlorate Concentration Trends
- Figure 23 Seep Well Field Perchlorate Concentrations
- Figure 24 Seep Well Field Perchlorate Concentration Trends
- Figure 25 Interceptor Well Field Average Perchlorate Concentration and Mass Removed
- Figure 26 Athens Road Well Field Average Perchlorate Concentration and Mass Removed
- Figure 27 Seep Well Field Average Perchlorate Concentration and Mass Removed
- Figure 28 Interceptor Well Field Total Dissolved Solids Concentrations
- Figure 29 Athens Road Well Field Total Dissolved Solids Concentrations
- Figure 30 Seep Well Field Total Dissolved Solids Concentrations
- Figure 31a Shallow Water Bearing Capture Zone
- Figure 31b Middle Water Bearing Capture Zone
- Figure 31c Deep Water Bearing Capture Zone
- Figure 32a Mass Flux Transect Locations
- Figure 32b Perchlorate Mass Flux at Interceptor Well Field
- Figure 32c Perchlorate Mass Flux at Athens Road Well Field
- Figure 32d Perchlorate Mass Flux at Seep Well Field
- Figure 33a Sampling Locations in Las Vegas Wash
- Figure 33b Annual Perchlorate Mass Loading in Las Vegas Wash
- Figure 34 Groundwater Levels and Stream Stage Near Pabco Road
- Figure 35a Piper Plot of Cation-Anion Data Collected Near the Seep Well Field
- Figure 35b Piper Plot of Cation-Anion Data Collected Near the Seep Well Field
- Figure 36a Perchlorate and Groundwater Elevation Across the Barrier Wall Near Well M-69
- Figure 36b Perchlorate and Groundwater Elevation Across the Barrier Wall Near Well M-70
- Figure 36c Perchlorate and Groundwater Elevation Across the Barrier Wall Near Well M-71
- Figure 36d Perchlorate and Groundwater Elevation Across the Barrier Wall Near Well M-72
- Figure 36e Perchlorate and Groundwater Elevation Across the Barrier Wall Near Well M-73
- Figure 36f Perchlorate and Groundwater Elevation Across the Barrier Wall Near Well M-74

LIST OF PLATES

Plate 1 All Well Location Map Plate 2 Potentiometric Surface Map, Shallow Water-Bearing Zone, Second Quarter 2015 Plate 3 West-East Hydrogeologic Cross Section A—A', Interceptor Well Field, Second Quarter 2015 Plate 4 West-East Hydrogeologic Cross Section B—B', Athens Road Well Field, Second Quarter 2015 Plate 5 West-East Hydrogeologic Cross Section C—C', Seep Well Field, Second Quarter 2015 Plate 6 Groundwater Total Chromium Map, Shallow Water-Bearing Zone, Second Quarter 2015 Plate 7 Groundwater Perchlorate Map, Shallow Water-Bearing Zone, Second Quarter 2015

- Plate 7a Groundwater Perchlorate Map, Shallow Water-Bearing Zone, Second Quarter 2002
- Plate 8 Groundwater Total Dissolved Solids Map, Shallow Water-Bearing Zone, Second Quarter 2015

APPENDICES

Appendix A

Groundwater Elevations and Analytical Data

Appendix B

Well Data Sheets

Appendix C

Groundwater Field Records

Appendix D

Data Validation Summary Report (DVSR)

Appendix E

Electronic Data Deliverable (EDD)

ATTACHMENTS

Attachment A

Phase III Groundwater Model Refinement

ACRONYMS AND ABBREVIATIONS

1. INTRODUCTION

In accordance with the Interim Consent Agreement between the Nevada Environmental Response Trust (the Trust) and the Nevada Division of Environmental Protection (NDEP), Ramboll Environ US Corporation (Ramboll Environ) submits this performance report to NDEP on behalf of the Trust for the Nevada Environmental Response Trust Site (the Site). The Site, which was formerly owned and operated by Tronox LLC (Tronox), comprises approximately 346 acres located within the Black Mountain Industrial (BMI) Complex in unincorporated Clark County and is surrounded by the City of Henderson, Nevada.

In conjunction with the settlement of Tronox's bankruptcy proceeding, the Trust took title to the Site and the groundwater extraction and treatment system (GWETS).^{[1](#page-10-0)} The effective date of the property transfer to the Trust and the Interim Consent Agreement between the Trust and NDEP was February 14, 2011. Tronox continues to conduct manufacturing operations on a portion of the Site leased from the Trust.

Envirogen Technologies, Inc. (Envirogen) currently operates and maintains the GWETS on behalf of the Trust.^{[2](#page-10-1)} TestAmerica Laboratories, Inc. (TestAmerica) acts as the Site's primary analytical testing laboratory.^{[3](#page-10-2)}

This report, covering the period July 2014 through June 2015, summarizes performance data for both the chromium and perchlorate removal programs based on sampling performed during this period. Specifically, this report describes:

- Regional groundwater conditions based on July 2014 through June 2015 groundwater levels;
- The hexavalent chromium remediation system (consisting of the on-site Interceptor Well Field [IWF], the off-site Athens Road Well Field [AWF],^{[4](#page-10-3)} and the related treatment systems) and its performance in carrying out the extraction and treatment of chromium;
- The perchlorate remediation system (consisting of the on-site IWF, the off-site AWF, the off-site Seep Well Field [SWF], the off-site seep capture sump^{[5](#page-10-4)}, and related treatment systems) and its performance in carrying out the extraction and treatment of perchlorate;

 \overline{a}

¹ Herein "GWETS" will be used to refer to the entirety of all systems and components of the groundwater extraction and treatment systems owned by the Trust, both on-site and off-site, including extraction well fields, treatment facilities, and groundwater conveyance systems.

² Veolia Water North America (Veolia), formerly US Filter Operating Services, operated the GWETS on behalf of Tronox beginning in 2003 and, after the Trust took title to the Site, continued to serve as the GWETS operator until July 24, 2013.

³ Eaton Analytical, formerly MWH Laboratories, served as the Site's primary analytical testing laboratory prior to April 1, 2013.

⁴ Although Athens Road has been renamed Galleria Drive, the Athens Road designation has been retained for the well field to maintain consistency with past reports.

⁵ The seep was previously reported to have not flowed since April 2007. However, groundwater was identified in this area in early February 2015. Discussion of the current status of this issue is included in Section 2.3.

- The distribution of total dissolved solids (TDS) concentrations at the Site;
- The performance metrics, 6 6 which are used to evaluate the performance of the GWETS;
- An update on activities related to the Continuous Optimization Program (COP);
- An update to the groundwater model, as described in Attachment A; and
- Proposed future activities, including ongoing activities related to the COP and the NERT Remedial Investigation (RI).

Annual groundwater sampling (completed in the second calendar quarter) is a coordinated sampling event with several neighboring companies participating. Data from groundwater samples collected by neighboring companies are incorporated and evaluated along with data from the NERT site. For the 2015 Annual Remedial Performance Report for Chromium and Perchlorate (the "2015 Annual Performance Report"), the Trust received information from American Pacific Corporation (AMPAC), Olin/Stauffer/Syngenta/Montrose (OSSM), Southern Nevada Water Authority (SNWA), and Titanium Metals Corporation (TIMET); their data were integrated into the development of the groundwater elevation and plume maps presented in Plates 2, 6, 7, and 8. Water monitoring data obtained from the City of Henderson (COH) and Bureau of Reclamation were also used in analysis of surface water and groundwater interactions presented in Section 6.4.4.

Furthermore, in this submittal, data from the ongoing NERT RI were also incorporated into the plume map interpretations and used qualitatively in the performance evaluation. The scope of work for the RI was outlined in the Remedial Investigation and Feasibility Study (RI/FS) Work Plan (ENVIRON 2014b), approved by NDEP on July 2, 2014. RI activities include investigation of soil and groundwater data gaps and additional groundwater modeling efforts. Although RI data have not yet been submitted to NDEP, available analytical data for shallow zone wells installed and sampled as part of the RI were used in the plume map interpretations, and thus are displayed on Plates 6, 7, and 8. These data have been validated in accordance with NDEP requirements and will be presented as part of the comprehensive soil and groundwater data compilation to be included in the forthcoming RI Report. Supporting documentation for these data, including an EDD and DVSR, will also be provided with the RI report.

This report is provided in both hard copy and electronic forms. Where electronic files are referenced or information is stated as provided on compact disc (CD), this information is contained on the CD attached to the hard copy report. Appendix A contains Table A-1, which has five quarters of analytical data from the Site, and Table A-2, which includes second quarter 2015 analytical data received from the other BMI Complex Parties. The analytical lab reports for the first and second quarter 2015 groundwater monitoring events are also included in Appendix A (on the report CD). Appendix B contains well data

 6 Performance metrics were developed as part of the 2013 GWETS Optimization Work Plan (ENVIRON 2013d), approved by NDEP on December 3, 2013 (NDEP 2013c). These performance metrics differ from the metrics being utilized as part of NERT's monthly GWETS operations reporting, which were developed by Tetra Tech and included in their Enhanced Operational Metrics Proposal dated August 20, 2014 (Tetra Tech 2014a).

sheets for the monitoring program wells, which show groundwater elevations, perchlorate concentrations, and chromium concentrations over time for each well, in addition to well construction details and the location of the UMCf contact. In addition, if the well is an extraction well, the pumping rate, specific capacity, and estimated mass removal of perchlorate and chromium over time are shown. Appendix C contains the field records from July 2014 to June 2015 (on the report CD). Appendix D contains the Data Validation Summary Report (DVSR) (on the report CD). Appendix E contains the Electronic Data Deliverable (EDD). The EDD includes an Access[®] compatible data file (on the report CD) containing the analytical results from the period July 2014 to June 2015, and an Access© compatible data file (on the report CD) containing water level monitoring data from the period July 2014 to June 2015. Attachment A contains the Phase III Groundwater Model Refinement Report, which describes further refinement of the steady state groundwater model.

2. AREA GROUNDWATER CONDITIONS

The locations of the groundwater extraction well fields are shown on Figure 1a, a map covering the area between the Site and Las Vegas Wash. Figure 1b is a guide showing the locations of various well transects that are discussed in subsequent sections of the report. Plate 1 shows the locations of all active wells in the vicinity. Discussion of the overall groundwater conditions follows below. The remainder of this section discusses the hydraulic performance of each of the well fields, starting with the on-site extraction well field, the IWF, and proceeding northward to the successively downgradient extraction well fields, the AWF and the SWF.

Ground surface elevations across the Site range from 1,677 to 1,873 feet above mean sea level. The ground surface across the Site generally slopes downward to the north at a gradient of approximately 0.02 feet per foot (ft/ft). Off site to the north, the topographic surface continues at the same gradient to approximately Sunset Road, at which point it flattens to a gradient of 0.01 ft/ft to the Las Vegas Wash. The shallow groundwater gradient generally mimics the surface topography.

The NDEP has defined three water-bearing zones (WBZs) of interest in the vicinity of the Site, including the Shallow, Middle, and Deep WBZ. $⁷$ $⁷$ $⁷$ The Shallow WBZ, which extends to</sup> approximately 90 feet below ground surface (bgs), is unconfined to partially confined, and is considered the water table aquifer. Unless otherwise stated, discussions of groundwater in this report refer to the Shallow WBZ, which contains the saturated portions of the Quaternary alluvium (Qal) and the uppermost portion of the Upper Muddy Creek Formation (UMCf).

Investigations of the Middle WBZ at the Site and surrounding sites indicate, with a few exceptions, a vertical upward gradient between the Middle and Shallow Zones that generally increases with depth. In the vicinity immediately downgradient of the IWF, vertical head differences between Middle and Shallow Zone wells ranged from 5 feet to 13 feet during the reporting period, with calculated vertical gradients ranging between 0.05 and 0.2 ft/ft in the upward direction. Upward vertical gradients were generally more prominent near the western and central portions of the barrier wall. At the AWF, two wells are screened within the UMCf, PC-134A and PC-137, to depths of 70 and 73.6 feet, respectively.^{[8](#page-13-1)} During the reporting period, the vertical head differences measured between PC-134A and PC-137 and corresponding wells screened within the Qal were 0.7 feet and 1.7 feet, respectively, with very slight downward vertical gradients of 0.03 and 0.05 ft/ft. Vertical gradients have not been evaluated near the SWF due to a lack of wells screened below the Oal.

During the current reporting period, shallow groundwater was generally encountered in on-site wells between 20 and 50 feet bgs and is generally deepest in the southernmost portion of the Site. North of the Site, beyond Boulder Highway, shallow groundwater is

⁷ NDEP guidance for the water-bearing zones can be viewed at http://ndep.nv.gov/bmi/docs/090106_hydro_litho.pdf

⁸ Groundwater wells have been recently installed deeper within the UMCf in this area as part of the RI. The initial data from these wells suggest that an upward vertical gradient exists deeper in the UMCf. Future submittals will include data from these deeper wells.

generally encountered between four and 30 feet bgs, becoming shallower as it approaches the Las Vegas Wash.

Plate 2, the *Potentiometric Surface Map: Shallow Water-Bearing Zone*, *Second Quarter 2015,* is based on groundwater elevation measurements collected from the Trust, AMPAC, OSSM, SNWA, and TIMET wells during second quarter 2015. The potentiometric surface map for the Shallow WBZ was created by interpolating measured water levels at shallow zone wells onto a grid using KT3D_H20 $^{\circ}$ (v3.0) and then contouring the gridded data using ArcGIS Spatial Analyst. KT3D_H20 is a software program specifically designed for interpolating water level data using kriging, which combines information about sources and sinks with water levels measured at wells.^{[10](#page-14-1)} The major sources and sinks of water that were incorporated into the interpolation using KT3D_H20 were: All three Trust-owned extraction well fields, OSSM extraction wells and injection trenches, TIMET extraction and injection wells, AMPAC extraction wells, and the COH Bird Viewing Ponds.

Groundwater flow direction at the Site is generally north to northwesterly, whereas north of the Site, the direction changes slightly to the north-northeast. This generally uniform flow pattern may be modified locally by subsurface alluvial channels cut into the underlying UMCf; the on-site bentonite-slurry groundwater barrier wall (the "barrier wall"); localized areas of recharge from on-site storm water retention basins (discussed below); off-site recharge from the COH Bird Viewing Ponds; groundwater extraction from the IWF, AWF, and SWF; and nearby groundwater extraction conducted by OSSM, TIMET, and AMPAC. Historically, on- and off-site artificial groundwater highs or "mounds" were observed around the on-site recharge trenches^{[11](#page-14-2)} and the COH Water Reclamation Facility (WRF) Rapid Infiltration Basins (RIBs)^{[12](#page-14-3)}; however, both of these have ceased operation.

During the 2011-2012 interim soil removal action, the Site was graded such that storm water would be retained on-site. Two retention basins and a drainage channel were constructed: 1) the Central Retention Basin, located approximately 800 feet south (upgradient) of the IWF and 2) the Northern Retention Basin, located approximately 300 feet north (downgradient) of the IWF. A shallow channel located along the eastern side

^{-&}lt;br>9 Karanovic, M., Tonkin, M., and Wilson, D. 2009. KT3D_H2O: A Program for Kriging Water Level Data Using Hydrologic Drift Terms. Ground Water, Vol. 47, N0. 4:580-586.

 10 One limitation of KT3D_H2O is that it cannot represent a barrier to groundwater flow, such as the barrier wall downgradient of the IWF. In the vicinity of the IWF, the barrier wall has a significant effect on the potentiometric surface, so instead of KT3D_H2O a different approach was used to generate contours for the inset map showing the IWF. The potentiometric surface near the IWF was estimated by fitting the trend in water levels using an analytical element model and then kriging the well measurements after removing the trend. The simple analytic element model included the extraction wells at the IWF and the barrier wall, and was developed using the TimML software v3.4 (a multiaquifer analytical element model). This approach is essentially equivalent to the KT3D approach, but allows the inclusion of the barrier wall. The final potentiometric surface was calculated as the sum of the trend obtained from the analytical element model and the output from kriging of the detrended data. The resulting grid of interpolated water levels was contoured using ArcGIS Spatial Analyst in the same way as for the other areas.

¹¹ Reinjection of stabilized Lake Mead water ceased in September 2010 when the recharge trenches were removed to accommodate soil excavation and remediation activities at the Site. They have not been replaced.

 12 Since the completion of the COH WRF in 2008, discharge of treated effluent to the Pabco Road RIBs has ceased; however, groundwater mounding events continued to be observed into late 2011, although lessening in intensity. The most recent mounding events are likely attributable to the operation of the COH Bird Viewing Ponds located west of the RIBs.

of the Site connects the two retention basins and conveys overflow from the Central Retention Basin into the Northern Retention Basin. Surface runoff from on-site areas and a majority of water collected by the storm sewer network within the Tronox-leased area are directed to the Central Retention Basin. Given the topography along the western property boundary, there is the potential for a small volume of storm water to enter the Site from the west through surface flow, which is collected in topographic depressions on the Site and/or in the Central Retention Basin. Surface runoff from north of the former Beta Ditch is directed to the Northern Retention Basin. The design capacities of the Central and Northern Retention Basins are approximately 1.3 and 1.2 million cubic feet, respectively (RCI Engineering 2010).

The retention basins have altered the location and extent of infiltration at the Site and thereby have had significant effects on groundwater conditions. Following a series of storm events between August and October 2012, storm water collected in the Central Retention Basin altering local infiltration pathways and influencing downgradient groundwater conditions at the IWF, the effects of which have been discussed previously beginning with the 2012 Semi-Annual Performance Report (ENVIRON 2013a). The effects included elevated water levels in and around the IWF which resulted in the mobilization of perchlorate previously bound to vadose zone soils. Mobilized perchlorate migrated to underlying groundwater and was subsequently captured in the IWF, resulting in increased perchlorate mass removal from the Site. It is anticipated that similar effects may be seen in the future following large storm events.

During the current reporting period ending June 2015, groundwater elevation trends at the Site were relatively consistent with the previous five quarters. Groundwater elevations in the vicinity of the barrier wall (described below in Section 2.1), which were elevated during portions of 2013, generally have returned to pre-November 2012 levels.

2.1 Interceptor Well Field Area

The location of the IWF area is shown on Figure 1a. A barrier wall was constructed at the Site in 2001 as a physical barrier across the higher concentration portion of the perchlorate/chromium plume. The barrier wall is approximately 1,600 feet in length and 60 feet deep and constructed to tie into approximately 30 feet of the UMCf. The IWF consists of a series of 27 active groundwater extraction wells that are situated south (upgradient) of the barrier wall.

The average discharge rate for each IWF well active during July 2014 to June 2015 is shown in Table 1, along with the annual average discharge rates from the four previous years. The combined discharge of the IWF averaged 68.7 gallons per minute (gpm) from July 2014 to June 2015. As seen in Table 4, average IWF extraction rates decreased from 71.9 gpm in July 2014 to 67.9 gpm in November 2014. Average extraction increased to 71.5 gpm in December 2014 following extraction rate adjustments as part of the 2013 GWETS Optimization Project, before decreasing to 64.7 gpm in June 2015 due primarily to various outages and maintenance activities involving wells I-AA, I-V, I-X, and I-Z (Tetra Tech 2015c). Over the last five years of operation, the combined discharge of the IWF averaged 68.3 gpm. For comparison, in June 2001, prior to the installation of the barrier wall, the 22 wells comprising the IWF at that time averaged a combined discharge of 24.7 gpm.

Groundwater recharge trenches located north (downgradient) of the barrier wall were originally installed to receive extracted and treated groundwater, but were used in the more recent past to inject stabilized Lake Mead water into the subsurface to replace water extracted by the IWF beginning in 1999. Injection ceased in September 2010 when the recharge trenches were removed to accommodate soil excavation and removal activities at the Site.

Plate 3, *West-East Hydrogeologic Cross Section A-A' – Interceptor Well Field, Second Quarter 2015,* shows water levels in the pumping interceptor wells and adjacent monitoring wells during May 2015, and the relationships between the pre-pumping and current groundwater levels in the vicinity of the IWF. The cross section also shows the series of narrow, shallow alluvial channels separated by UMCf ridges, some of which are above the current groundwater level. In general, water elevations in monitoring wells near the IWF in May 2015 have returned to levels seen prior to the late-2012 storm events. As seen in Plates 2 and 3, water levels in the pumping wells indicate that the individual wells are creating localized groundwater depression zones extending to the Qal/UMCf interface.

Figures 2a through 2f present historical (January 2006 to June 2015) water elevations for selected pairs of monitoring wells located on opposite sides of the barrier wall. As shown on the figures, between July 2014 and June 2015, water levels in wells directly downgradient (north) of the barrier wall (wells M-69 through M-74) were generally five to twelve feet lower than water levels in corresponding wells upgradient (south) of the wall (wells I-Y/M-167, M-55, M-56, M-58, M-67, and M-68). The large drop in measured groundwater elevations across the barrier wall indicates that the wall is generally an effective barrier to shallow groundwater flow. Further analysis of barrier wall performance is presented in Section 6.4.7.

Figures 2a through 2f show that, beginning in January 2006, water levels in wells downgradient of the barrier wall showed a continual decline until February 2008 when refurbishment of the recharge trench was completed allowing increased recharge rates and a corresponding rise in water levels. Peaks in water levels in downgradient wells observed in July 2008 and May 2010 (Figures 2a through 2c, and to a lesser extent on Figures 2d through 2f) are in response to increased recharge rates during those times. These figures also show a significant decline in water elevations in the downgradient wells beginning around September 2010, when the recharge trenches were shut down and groundwater mounding associated with the recharge began to dissipate.

As seen on Figures 2a through 2d, groundwater elevations downgradient of the barrier wall continued to decline during the current reporting period and most are now consistent with pre-November 2012 levels, the continuation of a trend that began in approximately September 2013. Figures 2e and 2f show increases in groundwater elevations in both downgradient and upgradient wells at the east end of the barrier wall beginning in late 2013 to early 2014, with the response first seen in the downgradient wells. The timing corresponds to the installation of a new barrier wall by TIMET at the northern edge of their property. Monitoring wells M-129 and M-130, which are located east of the NERT barrier wall and thus closer to TIMET's barrier wall, are sampled annually and have also shown increasing groundwater elevations since installation of TIMET's barrier wall.

Between 2013 and 2015, groundwater elevations have increased by 2.1 and 0.87 feet in M-129 and M-130, respectively. Therefore, it appears that the increases in groundwater elevations seen at the east side of the NERT property are likely the result of groundwater mounding upgradient of TIMET's newly-constructed barrier wall. Although operation of TIMET's barrier wall and extraction well system do not appear to have changed significantly during the current reporting period, groundwater elevations downgradient of the barrier wall decreased by approximately 0.5-1 feet during 2015.

2.2 Athens Road Well Field Area

The AWF is approximately 8,200 feet north (downgradient) of the barrier wall and the IWF. The AWF was constructed as a series of 14 groundwater extraction wells screened in the Qal at seven paired well locations that span approximately 1,200 feet across two alluvial paleochannels located on either side of an UMCf ridge. The AWF was completed in March 2002 and continuous pumping began in mid-October of that year. The well pairs act in concert, with one well pumping while the adjacent well is used to measure water levels and monitor the effect of pumping on the aquifer. In September 2006, a fifteenth standalone well, ART-9, began full-time operation after groundwater elevations at the AWF dropped below a level where ART-6/6A could be effective. Wells ART-7B and PC-150 were connected to the AWF during the current reporting period as part of the 2013 GWETS Optimization Project and began operating as extraction wells in October 2014 and November 2014, respectively. These two new wells were designed to address potential capture gaps identified as part of the 2011-2012 Annual Performance Report (ENVIRON 2012). Further analysis of AWF performance following implementation of the 2013 GWETS Optimization Project was described in Attachment A of the 2014 Semi-Annual Performance Report.

The average discharge rate for each AWF pumping well from July 2014 to June 2015 is shown in Table 2, along with the average annual discharge rates for the previous four years. The combined discharge rate of the AWF averaged 285.6 gpm from July 2014 to June 2015, which represented an increase in extraction rate when compared with the previous four years. As seen in Table 4, AWF extraction rates gradually increased to 292.8 gpm in September 2014 followed by a decrease to 277.5 gpm in November 2014 due to several outages involving ART-9 and various adjustments made in response to these outages (Tetra Tech 2015b). Extraction rates increased to 283.7 gpm in December 2014 following activation of PC-150 and ART-7B as part of the 2013 GWETS Optimization Project. Monthly average extraction rates were generally consistent through the end of the reporting period, ranging from 283.6 to 287.4 gpm. Over the last five years of operation, the combined discharge of the AWF has averaged 278.3 gpm.

Plate 4, *West-East Hydrogeologic Cross Section B-B' – Athens Road Well Field, Second Quarter 2015,* shows the current water levels in the AWF pumping wells and adjacent monitoring wells, and the relationships between the pre-pumping and current groundwater levels in the vicinity of the AWF. As shown on Plate 4, the extraction wells in the AWF primarily target two alluvial sub-channels separated by a ridge of the UMCf. Groundwater levels are currently much lower than they were in 2002 before pumping began, and the Qal overlying the UMCf ridge has been partially dewatered. Historical groundwater level trends for selected wells are shown on Figure

3. In general, the water elevations in the AWF are consistent with water elevations from one year ago.

Groundwater levels are currently much lower than they were in 2002 before pumping began, and the Qal overlying the UMCf ridge has been partially dewatered. Historical groundwater level trends for selected wells are shown on Figure 3. In general, the water elevations in the AWF are consistent with water elevations from one year ago.

2.3 Seep Well Field Area

The SWF and the seep capture sump,^{[13](#page-18-0)} located approximately $4,500$ feet north (downgradient) of the AWF near the Las Vegas Wash, are shown on Figure 1a. When pumping began in July 2002, the SWF consisted of three extraction wells (PC-99R2/R3, PC-115R, and PC-116R) situated over the deepest part of the alluvial channel and a seep capture sump designed to capture an intermittent surface seep. Five additional wells (PC-117, PC-118, PC-119, PC-120, and PC-121) were completed in February 2003 and an additional well (PC-133) was completed in December 2004. Presently, the SWF consists of 10 extraction wells—two of which (PC-99R2 and PC-99R3) are connected and operate as one combined well. The wells comprising the SWF are screened across the full thickness of the Qal and across the deepest portion of an alluvial channel.

The SWF has been effective in lowering groundwater levels in the vicinity of the seep; as a result, the surface seep reportedly had not flowed since April 2007, although the location was not regularly inspected as part of the groundwater monitoring program. During the current reporting period, on February 4, 2015, NDEP reported that groundwater was discharging to the surface from the eastern side of the seep capture sump and overtopping the sump. Inspection by NERT personnel indicated that water was overflowing the sump at a rate of approximately 1.5 gpm. As an interim response, water was removed from the seep capture sump using a vacuum truck and pumping rates were subsequently increased at the east end of the SWF (wells PC-133, PC-117, PC-116R, and PC-99R2/R3) in order to lower the water table in the vicinity of the seep capture sump and reduce the potential for future discharge from the sump. Water stopped overtopping the seep capture sump approximately four days after extraction rates were increased, and monitoring data from nearby wells PC-96 and PC-97 indicates that the increased extraction rates had lowered the water table by approximately 0.4-0.5 feet. After one month of continuous increased pumping, water levels dropped to three inches below the rim of the seep capture sump.

The surface flow from the seep capture sump is likely the result of seasonal changes in the water table elevation, which may have been further aggravated by recent tamarisk removal efforts. On April 7, 2015, the Trust submitted a memo to NDEP detailing the interim response actions near the seep and requesting permission to discontinue interim response measures due to the current hydraulic limitation of the GWETS and the anticipated implementation of the COP (NERT 2015). NDEP approved discontinuation of the interim measure on April 9, 2015 (NDEP 2015b) and SWF extraction rates were returned to normal on April 22, 2015.

¹³ The seep capture sump was reportedly last operated in April 2007 and was decommissioned (pump removed and piping blocked) shortly thereafter. Currently only the seep sump remains.

The average discharge rate for each SWF pumping well during July 2014 to June 2015 is shown in Table 3, along with the discharge rates for the previous four years. The combined discharge rate of the SWF averaged 536.0 gpm during the current reporting period, which is higher than combined pumping rates between July 2010 and June 2012 and between July 2013 and June 2014. Average monthly extraction rates during the current reporting period ranged from 517 gpm to 595.8 gpm, with the highest extraction rates observed in February and March 2015 due to the seep capture sump surface flow interim response measures. Over the last five years of operation, the combined discharge of the SWF averaged 532.3 gpm.

Plate 5, West-East Hydrogeologic Cross Section C-C' – Seep Well Field, Second Quarter 2015, shows the current water levels in the SWF pumping wells and adjacent monitoring wells, and the relationships between the pre-pumping and current groundwater levels in the vicinity of the SWF. Plate 5 shows that the alluvial channel in the SWF is much less incised into the underlying UMCf than at the AWF, and that the configuration of the alluvial channel is a broad shallow feature about 800 feet wide and averaging about 45 feet thick. In May 2001, before pumping began, the groundwater level in the area was shallow and would intersect the surface each winter forming a seep. Based on water level measurements collected in May 2015, water levels in the SWF are generally five to ten feet lower than pre-pumping levels and consistent with historical trends with the exception of extraction well PC-133 where the measured water levels have remained elevated from May 2014 through June 2015. Groundwater elevations in nearby monitoring wells (PC-92 and PC-91) were approximately 5 feet lower than the elevation measured in PC-133 during May 2015. In addition, as discussed in Section 4.1.3, concentrations of perchlorate have fluctuated recently in PC-133 without an apparent cause. The effort to quantify flows into the SWF, as described at the end of Section 6.4.4, including deployment of transducers and sampling for additional geochemical parameters, will be used as an opportunity to investigate the potential reasons for the inconsistencies observed in PC-133.

Groundwater levels at the SWF are currently lower than they were in 2001, before pumping began. Historical groundwater level trends for selected wells are shown on Figure 4. Since the middle of 2012, groundwater elevations at the SWF appear to be trending higher, although seasonal patterns are also apparent.

2.4 Groundwater Treatment Overview

Treatment of chromium-contaminated groundwater (primarily from the IWF) occurs via the on-site Groundwater Treatment Plant (GWTP), 14 which chemically reduces hexavalent chromium and removes total chromium via chemical precipitation. A small ferrous sulfate drip system, which was used at the AWF lift station (Lift Station #3) to treat chromium present (at lower concentrations) in groundwater extracted by the AWF, ceased operation in August 2014 after it was determined that the low concentrations of hexavalent chromium from the AWF did not require treatment ahead of the fluidized bed reactors (FBRs) (Tetra Tech 2014b). This change in operation, which is further discussed

¹⁴ By convention, the "GWTP" consists of only the on-site hexavalent chromium treatment plant. The name pre-dates the installation of any of the perchlorate treatment systems and related components.

in Section 3.2, does not appear to have had a significant effect on overall GWETS performance.

Treatment of perchlorate-contaminated groundwater from all well fields occurs via the on-site FBRs, which biologically remove perchlorate as well as chlorate, nitrate, and trace concentrations of residual chromium. A simplified process flow diagram is presented on Figure 5. Monthly extraction rates for individual IWF, AWF, and SWF wells are presented in Table 4.^{[15](#page-20-0)} Routine maintenance is completed as needed at the GWTP and FBRs. The performances of the chromium and perchlorate treatment systems are described in Sections 3.2 and 4.2, respectively.

¹⁵ The average total influent reported in Table 4 differs from the average total effluent of the GWETS. The discrepancy is the result of flow into and out of GW-11, evaporation from GW-11, and additions of stabilized Lake Mead water, which are used for various maintenance procedures. Perchlorate removal calculations are based on the extraction rates at each individual extraction well for the IWF, AWF, and SWF.

3. CHROMIUM CAPTURE AND TREATMENT

The components of the chromium capture system consist of the IWF, the barrier wall, and the AWF. As discussed previously, recharge trenches located downgradient of the barrier wall were formerly part of the chromium remediation system. The locations of these components are shown on Figure 1a. For the 12-month period lasting from July 2014 to June 2015, a total of approximately 2,480 pounds of chromium were captured and removed from groundwater. The treatment of chromium-contaminated groundwater is discussed in Section 3.2.

3.1 Chromium Plume Configuration

Table A-1 in Appendix A contains analytical and groundwater elevation data for the last five quarters. Table A-2 in Appendix A contains second quarter 2015 analytical and groundwater elevation data received from AMPAC, OSSM, TIMET, and SNWA. Appendix B contains well data sheets showing chromium concentration trends (as well as perchlorate concentrations and groundwater elevations) in individual wells over time. Plate 6 presents an isoconcentration map of the chromium plume from its on-site source northward to the Las Vegas Wash. In general, the current isoconcentration map is similar to the 2014 map but includes some differences due to the following:

- Additional data collected by other parties not evaluated in previous years have been included in this year's plume map, which has altered the plume from previous interpretations.
- As discussed in Section 1, available shallow groundwater data collected as part of the RI have been included to address data gaps from previous interpretations. RI data as shown on Plate 6 have been validated and will be formally submitted, along with supporting database and laboratory documentation, as part of the upcoming RI Report.
- As part of the COP, a subsurface conditions evaluation was performed in part to define the contact surface between the UMCf and the Qal, as discussed in Section 6.6. This evaluation resulted in a reinterpreted configuration of the paleochannel network, the effects of which have altered the current plume map.
- The chromium isoconcentration map was initially created by interpolating lognormalized concentrations using kriging in ArcGIS. Analytical data collected as part of the RI were then qualitatively evaluated to identify spatial trends in areas with data gaps. Identified trends were incorporated into the isoconcentration map by digitizing hand-drawn contours, further altering the plume from previous interpretations.
- Chromium concentrations downgradient of PC-150 have decreased compared to 2014 data, altering the shape of the plume in this area.
- On-site chromium concentrations, particularly in the vicinity of the barrier wall, are slightly lower than they were in 2014, resulting in alterations to the plume in this area.

Based on the second quarter 2015 chromium analytical results, the portion of the chromium plume with the highest concentrations remains south (upgradient) of the barrier wall where it is captured by the IWF. In this area, the highest chromium concentrations in shallow groundwater continued to be centered near the middle of the IWF in well I-T (25 milligrams per liter, or mg/L). North of the barrier wall, the highest total chromium concentration was 9.4 mg/L in groundwater collected from well M-73, located north of wells I-I and I-Z. North of the former recharge trenches, the highest total chromium concentration detected in second quarter 2015 was 3.6 mg/L in groundwater collected from well PC-136, located at the AWF and screened within an alluvial sub-channel east of the UMCf ridge. This concentration is slightly lower than the concentration measured in second quarter 2014 (5.1 mg/L), representing generally stable year-over-year conditions in this portion of the plume. Total chromium concentrations in groundwater adjacent to well M-12A, located immediately north of Unit Building 4 on the upgradient edge of the main plume, have been generally declining since 2002 and have remained stable over the last year. At the end of the current reporting period, the total chromium concentration in groundwater collected from M-12A was 10 mg/L compared with 25 mg/L in May 2002.

In general, the overall lower concentrations observed in on-site wells located downgradient of the barrier wall compared with those upgradient indicate that the IWF is an effective barrier to migration of the main portion of the chromium plume. The predominantly upward vertical gradients and the fact that the barrier wall is keyed into the UMCf are important factors that appear to limit flow beneath the barrier.

3.1.1 Interceptor Well Field Area

The IWF captures the highest concentrations and the main portion of the groundwater plume located downgradient of the on-site source areas. Figure 6 shows the concentrations of total chromium in groundwater extracted by the IWF pumping wells over the last five quarters. Chromium concentrations during the current reporting period were generally similar to previous quarters, with the exception of an anomalous result at well I-G in second quarter 2015.

Chromium concentration data from groundwater samples collected from select wells (M-11, M-23, M-36, M-38, M-72, and M-86)^{[16](#page-22-0)} over time are presented in Figure 7. Groundwater samples collected from monitoring well M-11, located immediately downgradient of the former primary source area (Unit Buildings 4 and 5), illustrate that concentrations have remained relatively stable over the last ten years with a concentration of 1.4 mg/L at the end of the current reporting period. Total chromium concentrations measured in groundwater from well M-38, located upgradient of the IWF, were consistent with recent concentrations observed over the last year (17 mg/L in May 2015). The concentration of chromium in groundwater collected from well M-72, located between the barrier wall and former recharge trenches, has varied between 5.3 and 9.8 mg/L during the current reporting period, with a value of 8.8 mg/L measured in May 2015. Concentrations in M-72 have increased slightly since approximately November 2010, following the shutdown of recharge trenches in September 2010. This suggests that the former recharge trenches either diluted concentrations in these wells, prevented lateral migration through or around the barrier wall, or mitigated the upward diffusion of

¹⁶ These wells were selected because they are the five "Consent Order Appendix J Wells" that were historically presented for evaluating performance of the chromium mitigation program. Figure 7 has historically presented data for well M-36; however, M-36 was damaged in June 2013. Data collected from nearby well M-38 is presented in Figure 7 to replace M-36. $\overline{}$

chromium from the UMCf. Further evaluation of the barrier wall's effectiveness is presented in Section 6.4.7.

3.1.2 Athens Road Well Field

The AWF is designed to intercept residual chromium in groundwater downgradient of the IWF and the Site. Based on total chromium concentrations in groundwater downgradient of the AWF, the system is operating effectively; nonetheless, as described in Attachment A of the 2014 Semi-Annual Performance Report, wells ART-7B and PC-150 were activated as extraction wells during the current reporting period to enhance capture. Downgradient of the AWF in the Athens Road Piezometer or "ARP" well line, the highest measured concentration of total chromium during the second quarter 2015 sampling event was 0.27 mg/L in well ARP-6B. Chromium concentrations in MW-K4, located further west, are typically equal to or greater than the concentrations in ARP-6B. However, chromium concentrations in MW-K4 decreased over the last five quarters to a low of 0.068 mg/L in May 2015.

Figure 8 shows the concentrations of total chromium across the area of the eight AWF pumping wells in addition to monitoring wells PC-18, PC-55, PC-122, PC-148, and PC-149 over the last five quarters, where data are available. PC-148 and PC-149 are monitoring wells that are situated across the top of the UMCf ridge with screened intervals primarily within the UMCf. As shown on Figure 8, chromium concentrations in the western subchannel (represented by wells west of PC-149) have been low relative to those in the eastern sub-channel (represented by wells east of PC-148). An additional extraction well, ART-9, was installed in this area in 2006 to capture this narrow channel of chromiumimpacted groundwater.

3.1.3 Seep Well Field

Wells in the SWF continue to generally contain less than 0.01 mg/L total chromium. Total chromium concentrations east of the SWF are slightly higher, but remained relatively stable over the reporting period. For example, the concentration of total chromium in groundwater collected from monitoring well PC-94, located east of the well field, was measured at 0.037 mg/L in second quarter 2015, greater than the concentration in groundwater at any of the SWF extraction wells (the highest chromium concentration detected in the SWF during second quarter 2015 was 0.0040 J mg/L in well PC-99R2/R3).

3.2 Chromium Treatment System

The operation and maintenance of the chromium treatment system, as well as the rest of the GWETS, has been performed by Envirogen since July 25, 2013. Prior to that date the GWETS was operated and maintained by Veolia.

Table 5 contains the July 2014 to June 2015 process treatment data from the on-site GWTP. The treated groundwater from the GWTP is pumped to the equalization tanks or GW-11,^{[17](#page-23-0)} where it is combined with water from the off-site groundwater collection

 \overline{a}

 17 GW-11 operated as an equalization basin from March 27 to August 6, 2014. When not operating as an equalization basin, groundwater enters the equalization tanks directly from Lift Station 2 and the GWTP. GW-11 started serving as an equalization basin again on January 6, 2015.

systems (AWF and SWF). The blended water flows through activated carbon beds before being pumped to the FBRs for treatment to remove perchlorate, chlorate, nitrate, and residual chromium.

As shown in Table 5, the total monthly chromium inflow concentration to the GWTP for this reporting period has been relatively stable in the range of 7.4 to 8.2 mg/L, which is slightly lower than the range of 8.0 to 10.6 mg/L reported for July 2013 to June 2014. The chemical reduction of hexavalent chromium and removal of total chromium via the GWTP during the reporting period has been consistently effective. The average monthly total chromium outflow concentrations for the last 12 months ranged from 0.23 to 1.31 mg/L. The average monthly hexavalent chromium outflow concentrations during the reporting period ranged from non-detect (<0.00025) to 0.0063 mg/L. As seen in Table 5, for the period between July 2014 and June 2015, approximately 2,270 pounds of chromium were removed from groundwater by the GWTP.

A trace amount of chromium is also removed in the FBRs. Results of total chromium analysis from weekly FBR influent and effluent samples are presented in Table 6. Based on an average influent total chromium concentration of 0.071 mg/L and an average flow rate of 845 gpm,^{[18](#page-24-0)} the FBRs were receiving about 0.72 pounds of chromium per day from the equalization tanks.

As previously discussed, until August 2014 a small ferrous sulfate drip system was used to treat the relatively low concentrations of chromium present in groundwater extracted at the AWF. Chromium concentrations in the FBR influent appear to have increased slightly since operation of the ferrous sulfate drip system ended in August 2014. For comparison, between June 2013 and July 2014 (the year preceding shutdown of the AWF ferrous sulfate drip system), total chromium influent concentrations averaged 0.034 mg/L and the FBRs were receiving about 0.36 pounds of chromium per day from the equalization tanks.

Despite receiving increased chromium per day during the current reporting period, total and hexavalent chromium concentrations in the FBR effluent are still well below the site's National Pollutant Discharge Elimination System (NPDES) permit requirements, as described below. The FBRs discharge treated water to the Las Vegas Wash just upgradient of the Pabco Road erosion control structure under authority of NPDES Permit NV0023060. Results of discharge monitoring performed between July 2014 and June 2015 are presented in Table 6. Effluent hexavalent chromium concentrations were between <0.00025 mg/L to 0.00034 J mg/L during the current reporting period – well below the effluent discharge limitation of 0.01 mg/L (daily maximum). Total chromium was detected in effluent samples at concentrations ranging from 0.004 to 0.043 mg/L and at an average concentration of 0.014 mg/L – also well below the effluent discharge limitation of 0.1 mg/L (daily maximum).

¹⁸ This flow rate is measured at the effluent totalizer and measures the throughput at the FBRs. This flow is not the same as the cumulative groundwater extraction rate as measured by the extraction well totalizers, since these readings do not account for flow into and out of GW-11, evaporation, and additions of stabilized Lake Mead water, which is used to maintain the mechanical pump seals.

The FBR system removed approximately 210 pounds of additional chromium over the 12 month period. The sum of the chromium captured and removed from groundwater between July 2014 and June 2015 by the GWTP and by the FBRs totaled approximately 2,480 pounds.

4. PERCHLORATE CAPTURE AND TREATMENT

The components of the perchlorate capture system consist of the IWF, the barrier wall, the AWF, the SWF, and the seep capture sump.^{[19](#page-26-0)} As discussed previously, recharge trenches located downgradient of the barrier wall were formerly part of the GWETS. The locations of these components are shown on Figure 1a. Perchlorate mass removal, flow rate, and average concentration information for the IWF, AWF, and SWF are presented in Table 7. Figure 9 presents the monthly perchlorate recovery totals and the relative contribution of the IWF, AWF, and SWF.

During the period July 2014 to June 2015, a total of approximately 508,200 pounds of perchlorate (approximately 1,390 pounds per day [lbs/day]) were captured and removed from groundwater by the GWETS. Of this total, approximately 287,500 pounds (approximately 790 lbs/day) were captured by the IWF; approximately 195,400 pounds (approximately 540 lbs/day) were captured by the AWF; and approximately 25,300 pounds (approximately 70 lbs/day) were captured by the SWF. These perchlorate removal calculations are performed by Tetra Tech, Inc. (Tetra Tech) consistent with the NDEP's revised and approved method to calculate perchlorate removed from the environment and are generated using flow and perchlorate concentration data for the three well fields.

The perchlorate mass removal during the current reporting period indicates a gradual return to conditions as they existed prior to late 2012. Starting in September 2012 there was a significant increase in the mass of perchlorate captured and removed from groundwater due to a series of storm events between August and October 2012 and subsequent infiltration, primarily at the Central Retention Basin, but in other areas as well, causing mobilization of perchlorate from the vadose zone. 20 20 20

4.1 Perchlorate Plume Configuration

Table A-1 in Appendix A contains analytical and groundwater elevation data for the last five quarters for wells monitored as part of the NERT groundwater monitoring program. Table A-2 in Appendix A contains second quarter 2015 analytical and groundwater elevation data received from AMPAC, OSSM, TIMET, and SNWA. Appendix B contains well data sheets showing perchlorate concentration trends (as well as chromium concentrations and groundwater elevations) in individual wells over time. Plate 7 shows the contoured perchlorate plume from the south end of the Site to the Las Vegas Wash, based on data collected in May and June 2015. The current isoconcentration map is generally similar to the 2014 map, but includes some significant differences due to the following:

 \overline{a}

¹⁹ As discussed in Section 1, the seep capture sump was decommissioned shortly after April 2007, which is when the sump reportedly last operated.

²⁰ Perchlorate captured and removed by the three well fields rapidly increased from approximately 1,300 lbs/day in August 2012 to 1,730 lbs/day in September 2012. In October 2012, perchlorate removal reached a peak of approximately 1,980 lbs/day. The effects of the storm events on groundwater conditions were discussed in previous performance reports beginning with the 2012 Semi-Annual Performance Report (ENVIRON 2013a).

- Additional data collected by other parties not evaluated in previous years have been included in this year's plume map, which has altered the plume from previous interpretations. In particular, the additional data available from AMPAC, which had not previously been evaluated, was used to interpret significant portions of the adjacent AMPAC perchlorate plume.
- As discussed in Section 1, available shallow groundwater data collected as part of the RI have been included to address data gaps from previous interpretations. RI data as shown on Plate 7 have been validated and will be formally submitted, along with supporting database and laboratory documentation, as part of the upcoming RI Report.
- As part of the COP, a subsurface conditions evaluation was performed in part to define the contact surface between the UMCf and the Qal, as discussed in Section 6.6. This evaluation resulted in a reinterpreted configuration of the paleochannel network, the effects of which have altered the current plume map.
- The perchlorate isoconcentration map was initially created by interpolating lognormalized concentrations using kriging in ArcGIS. Analytical data collected as part of the RI were then qualitatively evaluated to identify spatial trends in areas with data gaps. Identified trends were incorporated into the isoconcentration map by digitizing hand-drawn contours, further altering the plume from previous interpretations.

Based on second quarter 2015 perchlorate analytical results, the highest perchlorate concentration south (upgradient) of the barrier wall occurred in well I-AR (2,500 mg/L), in the western flank of the IWF, and near I-H (2,100 mg/L) near the center of the IWF. As seen in Figure 10, perchlorate concentrations at the IWF have been relatively stable over the last five quarters.

North of the barrier wall, the highest perchlorate concentrations in second quarter 2015 were detected in well M-140 (1,500 mg/L) located immediately downgradient and near the western end of the wall, and wells M-71 (1,100 mg/L), and M-72 (1,200 mg/L), which are located immediately downgradient and near the mid-point of the wall. North of the former recharge trenches, the highest perchlorate concentration in second quarter 2015 was 750 mg/L in well M-44, located between Warm Springs Road and Boulder Highway. The highest perchlorate concentration reported at the SWF during second quarter 2015 was 20 mg/L in well PC-99R2/R3, which is located in the center of the well field.

As a result of the comprehensive evaluation of perchlorate data received from the BMI Complex Parties and the initial evaluation of available RI data, areas of the NERT perchlorate plume have been revised compared to the 2014 perchlorate plume interpretation. In previous interpretations, the NERT and AMPAC perchlorate plumes were shown as isolated from one another, with a clean area extending from the OSSM well field and injection trenches to the COH Bird Viewing Ponds located downgradient. However, an initial evaluation of available RI data in conjunction with additional data from the BMI Complex Parties indicates the AMPAC plume to the west commingles with NERT's perchlorate plume. Furthermore, the re-interpretation of the subsurface geology and paleochannels conducted as part of the COP in 2015 has also informed the perchlorate plume characterization. The revised plume presented on Plate 7 accounts for the influence of AMPAC's perchlorate plume and the paleochannels on the area west of the NERT plume.

On Plate 7, a narrow band of increased perchlorate concentrations is shown between the AMPAC and NERT plumes surrounding wells H-56A and PC-31 extending along the paleochannel in that area. An additional area of increased perchlorate concentration is also shown extending downgradient through the paleochannel from AMPAC's plume source to well MC-47. Based on the revised interpretation of the paleochannels as shown on Plate 7, it appears that the perchlorate observed at H-56A and PC-31 originates from the area of increased concentrations observed at MC-47; however, because additional data within the paleochannel in that region are not available, this conclusion is not definitive. This issue will be further evaluated as part of the RI.

Plate 7 also shows comingling of the AMPAC and NERT plumes in the vicinity of the AWF. Data collected during the RI (both groundwater elevation and analytical results) from newly-installed wells west of the AWF (PC-154, PC-158, PC-159, and PC-160) indicate that the AWF (specifically ART-1 and to a lesser extent, ART-2) is likely extracting a portion of AMPAC's perchlorate plume located to the west. The groundwater elevation data indicate that groundwater flows from the eastern edge of AMPAC's plume towards the AWF. Analytical data indicate a relatively consistent concentration of perchlorate in samples from wells PC-154, PC-158, PC-159, and PC-160. The absence of groundwater quality data in this area was a data gap in previous interpretations of the plume. Downgradient groundwater conditions will be further examined to determine the extent of contamination migrating from the NERT site.

4.1.1 Interceptor Well Field Area

The IWF targets the highest concentrations of perchlorate at the Site. In general, perchlorate concentrations in groundwater downgradient of the IWF and barrier wall are significantly below concentrations observed in groundwater upgradient of these features. Figure 10 represents a west-east transect through the IWF and shows perchlorate concentrations from May 2002 compared to data for the last five quarters from the extraction wells. Seven of these wells (I-AA, I-AB, I-AC, I-AD, I-W, I-X, and I-Y) were activated as part of the 2013 GWETS Optimization Project. Following activation, extraction wells I-AB, I-AC, and I-AD were unable to achieve sustainable pumping rates and are currently idle.

Since November 2012, there has been significant variability in the perchlorate concentrations in the IWF wells due to a marked increase in perchlorate concentrations beginning in November 2012. A combination of factors is likely responsible for the observed increase and subsequent decrease in perchlorate concentrations within many of the IWF wells. These factors include high levels of precipitation during late 2012, the alteration of Site drainage patterns resulting from Site excavation and grading, and the potential mobilization of vadose zone perchlorate from infiltration at the Central Retention Basin. However, perchlorate concentrations have gradually decreased and are now consistent with levels prior to November 2012. During the reporting period, elevated perchlorate concentrations west of I-M existed in a relatively narrow area centered on well I-AR, while the elevated perchlorate concentrations east of I-M typically spanned a broader area extending from wells I-E to I-I. This concentration profile is similar, but less pronounced than in the dashed red line in Figure 10 depicting the May 2002 data with the exception of wells I-M, I-I, and I-K, where perchlorate concentrations during the

reporting period were higher than they were in 2002. Concentrations at I-K appear relatively stable over the reporting period, while concentration ranges at wells I-I and I-M spanned 460 and 560 mg/L, respectively, during the reporting period. These ranges are consistent with increased variability observed in perchlorate concentrations at the IWF since November 2012. Although higher variability remains compared to pre-November 2012 conditions, concentrations have become more stable recently. For comparison, measured perchlorate concentration ranges in wells I-I and I-M spanned 850 and 1060 mg/L in the five quarters immediately following August 2012.

Figure 11 charts perchlorate concentrations for select wells at the IWF over time. The graph shows generally decreasing trends since sampling for perchlorate began in 2002. Figure 12 represents a west-to-east transect through wells immediately downgradient of the barrier wall and shows perchlorate concentrations from May 2000 compared to data for the last five quarters. Perchlorate concentrations in wells immediately downgradient of the barrier wall remained elevated during the reporting period compared to late-2012 conditions (concentrations were 690 mg/L in well M-71 in November 2012 and ranged between 940 mg/L and 1,400 mg/L during the current reporting period). The variability in concentrations measured during the reporting period is most pronounced in the central portion of the well line.

Figure 13 charts perchlorate concentration and water elevation trends in monitoring wells M-100 and M-23, located approximately 700 and 1,300 feet north (downgradient) of the former recharge trenches, respectively. Figure 13 indicates a sharp decrease in perchlorate concentrations in both wells beginning in early 2002, shortly after the barrier wall was installed at the IWF. Water level trends reflect infiltration and mounding of water recharged to the subsurface through the former recharge trenches. Clogging of the trenches and reduced infiltration are reflected in the decreasing water levels beginning in approximately May 2007. The trenches were subsequently refurbished in February 2008 and June 2009 with water levels in well M-100 quickly rebounding and water levels in well M-23 rebounding somewhat more slowly. Operation of the trenches was suspended in September 2010, which corresponds with decreases in water levels in both wells M-100 and M-23. Well M-100 has been dry since December 2010. The water level in well M-23 has decreased approximately eight feet since the trenches were shut down. Perchlorate concentrations in well M-100 remained relatively stable from 2008 through 2010. Perchlorate concentrations in well M-23 have decreased significantly since July 2006.

4.1.2 Athens Road Well Field Area

The AWF captures perchlorate in groundwater at concentrations generally less than 500 mg/L. A west-east transect through the AWF, which charts perchlorate concentrations for the last five quarters, is shown on Figure 14. Perchlorate concentrations in the AWF's eight pumping wells are shown, in addition to monitoring wells PC-18, PC-55, PC-122, PC-148, and PC-149. The pumping wells shown include PC-150, which was activated as an extraction well during the reporting period. As shown on the figure, perchlorate concentrations on the western (PC-55 and ART-1) and eastern (PC-122) edges of the well field remain relatively low, consistent with previously identified trends. PC-150 exhibited

more variability during the reporting period possibly due to its activation as a pumping well in November 2014.

Figure 15 shows that overall perchlorate concentrations in the AWF have declined significantly since 2002. Concentrations in individual wells fluctuate between sampling events, but for most wells these fluctuations have moderated with time.

Approximately 250 feet north of the AWF, eight wells comprise the Athens Road Piezometer or "ARP" well line. Perchlorate concentrations across the ARP well line are presented on Figure 16, and perchlorate concentrations in these wells over time are shown on Figure 17.

As shown on Figure 16, perchlorate concentrations in the western side of the well line (represented by ARP-1, ARP-2/2A, and ARP-3/3A) and the eastern side of the well line (represented by ARP-4/4A, ARP-5/5A, ARP-6/6A/6B and ARP-7) have significantly decreased since 2002. This indicates that the AWF has been effective in capturing perchlorate contaminated groundwater in these sections of the plume. As shown on Figure 17, with the exception of wells MW-K4 and ARP-6/6A/6B, concentration trends in the ARP well line appear relatively stable. Concentrations in well MW-K4 initially declined with the onset of AWF operation in 2002 and dropped further when ART-9 began pumping in September 2006. Perchlorate concentrations in MW-K4 generally declined between January 2010 (300 mg/L) and December 2011 (150 mg/L), but rebounded during 2012, once again reaching 300 mg/L. These increases and decreases in perchlorate concentration in MW-K4 do not appear related to changes in water elevation. The higher and more variable perchlorate concentrations in well MW-K4 are likely influenced by the well's location with respect to subsurface alluvial channels within the UMCf. Analysis first presented in Appendix E of the 2011-2012 Annual Performance Report indicated that there could be a gap in the capture zone that may be responsible for the elevated concentrations in MW-K4 (ENVIRON 2012).

Perchlorate concentrations in MW-K4 declined during the current reporting period from 220 mg/L in July 2014 to a low of 41 mg/L in June 2015. Although the activation of upgradient extraction well PC-150 occurred in November 2014, it is not yet clear how much of an effect this had on the concentrations in MW-K4. No significant changes in perchlorate concentration were observed downgradient of well ART-7B, which was also activated as an extraction well during the current reporting period.

Between the ARP well line and the SWF are the COH WRF well line (wells PC-103, PC-98R, MW-K5, PC-53) and the Lower Ponds monitoring well line (PC-68, PC-62, PC-59, PC-60, PC-56, PC-58), located approximately 2,200 and 4,400 feet north (downgradient) of the AWF, respectively. Perchlorate concentrations in the COH WRF wells on a west-east transect are shown on Figure 18. Figure 19 presents perchlorate concentration trends for these same wells over time. As shown in the figures, current perchlorate concentrations are well below levels measured in the same wells in May 2002, especially in the center of the well line (Figure 18). Figure 19 shows perchlorate concentrations at the COH WRF well line have been relatively stable or gradually increasing since mid-2007.

Figure 20 shows historical water elevations at the COH WRF well line in PC-98R. This figure indicates that many of the historical low-concentration events in the wells appear to be associated with a rapid increase in the water levels, likely the result of increased infiltration from the COH WRF surface ponds. The significant groundwater "mounding events" since 2008 (when the operation of the COH RIBs ceased) are not as pronounced as previous ones and are presumed to be related to operation of the COH Bird Viewing Ponds or due to seasonal fluctuation. Recently, the more moderate changes in groundwater elevations appear to have little effect on perchlorate concentrations. Overall, perchlorate concentrations in PC-98R have been gradually increasing since about 2009. Immediately downgradient from PC-98R is the location of the proposed groundwater bioremediation pilot test intended to evaluate in-situ biological treatment for perchlorate (Tetra Tech 2015a).

The Lower Ponds well line is approximately 2,200 feet north of the COH WRF well line. Figures 21 and 22, the perchlorate west-east transect and trend chart for the Lower Ponds well line, respectively, show that current perchlorate concentrations are well below levels measured in the same wells in May 2002, especially at well PC-56 (Figure 21). Figure 22 shows that perchlorate concentrations present in the Lower Ponds well line are generally low and, with the exception of well PC-56, have been relatively stable since 2007. Perchlorate concentrations in well PC-56 have historically been higher and more variable than in other wells on the Lower Ponds well line. The higher and more variable perchlorate concentrations in well PC-56 may be influenced by the well's location with respect to a subsurface alluvial channel that runs north-south back towards the AWF. According to boring logs for these wells, the UMCf was encountered 12 to 20 feet deeper in PC-56 compared to nearby wells PC-58 and PC-60 suggesting it is within a narrow alluvial channel incised within the UMCf.

4.1.3 Seep Well Field Area

At present, the SWF consists of 10 extraction wells – two of which (PC-99R2 and PC-99R3) are connected and operate as one – positioned over the deepest part of a broad alluvial channel. The well field is located approximately 600 feet upgradient of the seep capture sump. The original three recovery wells in the SWF (PC-99R2/R3, PC-115R, and PC-116R) commenced pumping in 2002. In 2003, five additional wells (PC-117, PC-118, PC-119, PC-120, and PC-121), and in 2005, one additional well (PC-133), were completed in the SWF. Wells PC-120 and PC-121, located at the west end of the SWF line and away from the deepest portion of the subsurface alluvial channel, have not been continuously pumped since 2005 due to their low perchlorate removal efficiencies when compared with other SWF wells. Wells PC-120 and PC-121 are turned on for sampling or when maintenance is performed on other SWF wells.

Figure 23 shows perchlorate concentrations along a west-east transect for the last five quarters along with concentrations for each well during its first month of operation. This transect shows that the plume configuration has remained relatively stable, with a broad area of higher concentration centered on well PC-99R2/R3. Figure 24, which depicts perchlorate concentrations in each well, shows that perchlorate concentrations have significantly decreased since 2002. Perchlorate concentrations in PC-99R2/R3, PC-116R, and PC-117 remain relatively low but appear to be gradually increasing since about 2009 in a manner that is similar to upgradient well PC-56 (Figure 22) located at the Lower Ponds well line and PC-98R (Figure 20) located at the COH WRF well line.

SWF wells with lower concentrations of perchlorate (PC-119, PC-120, and PC-121) have been relatively stable with the exception of PC-133, which steadily increased from 0.63 mg/L in May 2012 to a high of 16.0 mg/L in February 2013. However, starting in March 2013, perchlorate concentrations in PC-133 decreased to a low of 1.5 mg/L in April 2014 before increasing to 14.0 mg/L by January 2015. From February 2015 to June 2015, the perchlorate concentrations in PC-133 remained between 9.0 mg/L and 11.0 mg/L. PC-133 is on the eastern edge of the alluvial channel away from the other SWF pumping wells, which pump at significantly higher rates. It is further noted that PC-133 was rehabilitated on September 30, 2013 to remove roots from the well in an effort to increase its extraction rate; however, the work, which included swabbing and pumping the well and replacing the pump and motor with higher capacity units, did not result in an increase in the extraction rate. The reasons for these concentration fluctuations and extraction limitations are unclear, but will be further evaluated as part of the effort to quantify flows to the SWF, as described in section 6.4.4.

As discussed in Section 2.3, on February 4th, 2015 NDEP reported that groundwater was accumulating in the seep capture sump and overtopping the sump. Inspection by NERT personnel indicated that water was overflowing the sump and discharging to the surface at a rate of approximately 1.5 gpm. Prior to this it was believed that the seep had been dry since April 2007. As reported to NDEP on April 7, 2015 (NERT 2015), two surface water samples were collected from within the seep capture sump and were analyzed by Envirogen using their on-site laboratory. The perchlorate concentrations in the samples were 950 and 890 mg/L. Pumping rates were subsequently increased at the east end of the SWF (wells PC-133, PC-117, PC-116R, and PC-99R2/R3) in order to lower the water table in the vicinity of the seep capture sump and reduce the potential for future discharge from the sump. Water stopped overtopping the seep capture sump approximately four days after extraction rates were increased, and monitoring data from nearby wells PC-96 and PC-97 indicate that the increased extraction rates lowered the water table by approximately 0.4-0.5 feet. After one month of continuous increased pumping, water levels dropped to three inches below the rim of the seep capture sump. As discussed in Section 2.3, NERT requested permission to discontinue interim response measures due to the current hydraulic limitation of the GWETS and the anticipated implementation of the COP; NDEP approved discontinuation of the interim measure on April 9, 2015 (NDEP 2015) and SWF extraction rates were returned to normal on April 22, 2015.

4.2 Perchlorate Treatment System

Throughout the reporting period, groundwater was captured both on-site and off-site, conveyed to the on-site treatment facilities, and treated biologically in the FBRs to remove perchlorate, chlorate and nitrate. As previously shown in Figure 9, the majority of perchlorate capture at the Site happens via the IWF (287,500 pounds), followed by the AWF (195,400 pounds), and the SWF (25,300 pounds). The SWF contributes the highest flow to the GWETS (an average flow rate of 536.0 gpm between July 2014 and June 2015) compared with the IWF (an average flow rate of 68.7 gpm) and the AWF (an

average flow rate of 285.6 gpm), but captures significantly lower concentrations of perchlorate (generally less than 10 mg/L).

As shown on Figure 25, the monthly average perchlorate concentrations captured at the IWF generally decreased from a high of about 1,890 mg/L in October 2002 to 732 mg/L in June 2012, the lowest recorded average concentration. The IWF's monthly average perchlorate concentration then doubled to 1,491 mg/L in December 2012. As reported previously, it is likely that additional perchlorate mass was mobilized via infiltration of storm water following the large rain events in the fall of 2012 leading to the historically high perchlorate concentrations and mass removals at the IWF. The calculated perchlorate mass removal has generally followed a similar trend. During the current reporting period, average concentrations in the IWF decreased from approximately 1,040 mg/L in July 2014 to 920 mg/L in June 2015, resulting in decreased mass removal. Barring additional historic rain events or changes in system operation, it is expected that the elevated perchlorate concentrations and mass removals will continue to decrease to levels similar to those prior to December 2012.

Figure 26 shows that perchlorate concentration and mass removal for the AWF have been decreasing since late 2002. During the current reporting period, concentrations and mass removal rates were relatively stable. In contrast to the IWF (Figure 25) where large increases and subsequent decreases in perchlorate concentrations and mass removal are evident starting in late 2012 following large rain events at that time, similar trends have not been observed at the AWF (Figure 26) in the succeeding years.

Figure 27 depicts a generally decreasing trend in monthly average perchlorate concentrations captured at the SWF from a high of approximately 82 mg/L in March 2003 to an average of approximately 11 mg/L between July 2014 and June 2015. The calculated perchlorate mass removal has generally followed a similar trend. The average perchlorate removal during the current reporting period is approximately 570 pounds per month greater than the average reported for the previous reporting period from July 2013 to June 2014.

Effluent from the FBRs has been discharged into Las Vegas Wash within the limits specified in the NPDES NV0023060 discharge permit. As shown on Table 8, between July 2014 and June 2015, the perchlorate influent to the FBRs ranged from 71 mg/L to 130 mg/L. Perchlorate was not detected at concentrations exceeding the laboratory sample quantitation limit (SQL) (<0.0025 mg/L) in effluent discharged to Las Vegas Wash during the current reporting period.

The perchlorate treatment system underwent a temporary process modification during the previous reporting period. The GW-11 pond, which had served as a holding area for untreated groundwater and off-specification effluent, was altered to function as an influent equalization basin starting on March 27, 2014. The change was designed to provide hydraulic retention upstream of the GWETS process units and dampen fluctuations in influent loading. However, plugging of filtration equipment proved to be a significant hindrance to the modification and the use of GW-11 as an equalization basin ended on August 6, 2014, during the current reporting period. Envirogen subsequently identified modifications to the filtration system, including the use of automatic filters,

which were fully implemented during the current reporting period. GW-11 began operating as an equalization basin again on January 6, 2015.

5. TOTAL DISSOLVED SOLIDS

Plate 8 shows the isoconcentration contours for TDS from the southern end of the Site to the Las Vegas Wash, based on data collected during second quarter 2015. In general, the current isoconcentration map is similar to the 2014 map with some local variances due to the following:

- Additional data collected by other parties not evaluated in previous years have been included in this year's plume map, which has altered the plume from previous interpretations. In particular, the additional data available from AMPAC and TIMET, which had not previously been evaluated, was used to interpret significant portions to the east and west of last year's plume extent.
- As discussed in Section 1, available shallow groundwater data collected as part of the RI have been included to address data gaps from previous interpretations. RI data as shown on Plate 8 have been validated and will be formally submitted, along with supporting database and laboratory documentation, as part of the upcoming RI Report.
- As part of the COP, a subsurface conditions evaluation was performed in part to define the contact surface between the UMCf and the Qal, as discussed in Section 6.6. This evaluation resulted in a reinterpreted configuration of the paleochannel network, the effects of which have altered the current plume map.
- The TDS isoconcentration map was initially created by interpolating log-normalized concentrations using kriging in ArcGIS. Analytical data collected as part of the RI were then qualitatively evaluated to identify spatial trends in areas with data gaps. Identified trends were incorporated into the isoconcentration map by digitizing handdrawn contours, further altering the plume from previous interpretations.

Figure 28 is a west-east transect through the IWF which charts TDS concentrations over the last five quarters. A comparison of Figure 10 and Figure 28, which show perchlorate and TDS, respectively, in each of the IWF wells, indicates that a broad zone of high TDS in the central part of the IWF coincides with the eastern area of elevated perchlorate concentrations. As with perchlorate, concentrations of TDS generally returned to pre-November 2012 levels across the IWF during the current performance period with the exception of an anomalously high TDS reading in well I-AC in fourth quarter 2014.

Figure 29 is a west-east transect through the AWF which charts TDS concentrations for the last five quarters. The figure shows that two zones of higher TDS exist at the AWF: one centered on well ART-8 on the west side of the AWF and one at wells ART-7 and PC-122 on the east end of the AWF. Concentrations of TDS in AWF wells remained relatively stable during the reporting period.

TDS concentrations in the SWF wells for the last five quarters are plotted on Figure 30. The highest TDS concentration during the reporting period (5,300 mg/L) was detected in well PC-99R2/R3 in October 2014. Higher TDS concentrations generally correspond with higher perchlorate concentrations in both AWF and SWF wells. TDS mapping and analysis in the northern portion of the plume, between the Bird Viewing Ponds and Las Vegas Wash, has also aided in interpretation of hydrologic conditions and the potential influence of surface water features, as further discussed in Section 6.4.4.
6. PERFORMANCE EVALUATION

This section provides an evaluation of the performance of the GWETS against a set of performance metrics developed in coordination with NDEP. These metrics are intended to establish a consistent framework for evaluating performance of the GWETS.

6.1 Performance Metrics

Performance metrics were developed as part of the 2013 GWETS Optimization Work Plan (ENVIRON 2013d), approved by NDEP on December 3, 2013 (NDEP 2013c). The metrics include those identified in the October 10, 2013 letter from NDEP (NDEP 2013b) commenting on the 2012-2013 Annual Performance Report, additional data requested in the April 9, 2014 letter from NDEP (NDEP 2014b) on the 2013 Semi-Annual Performance Report, and additional metrics^{[21](#page-36-0)} identified by ENVIRON International Corporation (ENVIRON, now known as Ramboll Environ). The approved performance metrics are outlined below:

- 1. Monthly perchlorate and chromium mass removal rates from the IWF, AWF, and SWF;
- 2. Perchlorate and chromium plume mass estimates;
- 3. The concentrations at which the Site is achieving 90% and 99% capture of perchlorate and chromium;
- 4. Perchlorate and chromium capture efficiency of the IWF, AWF, and SWF;
- 5. Mass loading of perchlorate and chromium in the Las Vegas Wash at Northshore Road;
- 6. The fraction of mass loading in Las Vegas Wash at Northshore Road that originates from the Site;
- 7. The amount of surface water from Las Vegas Wash and the COH Bird Viewing Ponds that is being extracted by the SWF; and
- 8. The environmental footprint of the GWETS with a focus on energy use.

The numbering of the metrics presented above was done only for clarity and does not reflect prioritization. The metrics are discrete measures of performance that will be used to understand and adjust GWETS performance over time.

6.2 Groundwater Model

A key tool for developing and implementing the performance metrics is the groundwater model. The groundwater model for the Site was originally developed by Northgate Environmental Management, Inc. (Northgate) and documented in the Capture Zone Evaluation (CZE) Report (Northgate 2010). The model was approved on April 4, 2013 by NDEP (NDEP 2013a). As part of the 2013 GWETS Optimization Project, the model was refined and updated to recent steady-state conditions. The modeling work follows the

-

²¹ These metrics are separate and distinct from those being utilized as part of NERT's monthly GWETS operations reporting, which were included in Tetra Tech's Enhanced Operational Metrics Proposal dated August 20, 2014 (Tetra Tech 2014a).

2013 GWETS Optimization Project Work Plan submitted by ENVIRON (now known as Ramboll Environ) to NDEP (ENVIRON 2013d). The updated model, known as the Phase I Model, was described in the 2013 Semi-Annual Performance Report (ENVIRON 2014a). A second phase of refinements and updates were made as described in Attachment A of the 2013-2014 Annual Performance Report (ENVIRON 2014c). The Phase III Model, which involves further refinement of the steady state model, is presented herein as Attachment A. The Phase III Model has recently been updated with second quarter 2015 pumping rates for evaluations presented in this report and shown in Tables 1 through 3. The second quarter 2015 pumping rates for OSSM, TIMET, and AMPAC wells have also been incorporated. A refined steady-state model (the Phase 4 model) will be submitted with the 2015 Semi-Annual Remedial Performance Report in April 2016. Following NDEP approval of the Phase 4 model, the transient groundwater model (Phase 5 model) will be developed as part of the RI effort.

6.3 Performance Evaluation Approach

An overall approach for evaluating metrics was established in the 2013 GWETS Optimization Project Work Plan (ENVIRON 2013d) and was described in the 2013 Semi-Annual Performance Report (ENVIRON 2014a). The performance metrics are focused mainly on perchlorate because the perchlorate plume is the most spatially extensive (i.e., the spatial extent of the chromium plume is contained within the perchlorate plume) and perchlorate represents the more immediate threat to off-site receptors due to its potential impacts on Las Vegas Wash. This is consistent with the focus of previous capture zone evaluations at the Site. The evaluation of GWETS performance using the metrics is consistent with United States Environmental Protection Agency (USEPA) guidance on evaluating capture zones for groundwater pump and treat systems (USEPA 2008).

6.4 Evaluation of Performance

In this section, the performance of the GWETS is discussed in relation to the metrics described in Section 6.1. The methodologies used for these evaluations are also described. This evaluation of performance also includes discussion of the operation of GW-11 in Section 6.4.6, as requested by NDEP in the April 9, 2014 comments on the 2013 Semi-Annual Performance Report (NDEP 2014b), and an evaluation of the continuing performance of the barrier wall in Section 6.4.7.

6.4.1 Mass Removal and Remaining Plume Mass

During the period July 2014 through June 2015, approximately 508,200 pounds of perchlorate (approximately 1,390 lbs/day) were captured and removed from groundwater by the GWETS as shown in Table 7. Of this total, approximately 287,500 pounds (approximately 790 lbs/day) were captured by the IWF; approximately 195,400 pounds (approximately 540 lbs/day) were captured by the AWF; and approximately 25,300 pounds (approximately 70 lbs/day) were captured by the SWF.

Tables 9 and 10 present perchlorate and chromium plume mass estimates for 2002, 2006, 2012, 2014, and 2015. Estimates of remaining plume mass were first presented in the 2012-2013 Annual Performance Report (ENVIRON 2013c) for years 2002, 2006, and 2012. No estimate of chromium mass for 2002 could be developed due to lack of data.

The mass estimates for 2015 were based on second quarter 2015 data. Isoconcentration maps were initially developed by interpolating log-normalized concentrations using kriging in ArcGIS. A previous comparison of three interpolation methods, including methods based on kriging, splines, and contours, showed that the methods give similar results (ENVIRON 2013c). Kriging is a standard interpolation method, but it is not able to incorporate abrupt changes in concentration levels observed at the barrier wall or well fields, and also neglects to account for other important hydrogeological features (such as the presence of paleochannels). Furthermore, kriging could not be used to qualitatively evaluate RI data, initial evaluations of which have identified certain changes in the plume extent, particularly between the AMPAC and NERT perchlorate plumes. To incorporate these features, hand-drawn contour lines were created and digitized in ArcGIS. It is important to note that because the plume interpretation was altered this year to incorporate available shallow groundwater data from the RI and information from the COP subsurface evaluations as discussed in more detail below, mass estimates have changed considerably from previous years, therefore, the current mass estimates are not comparable to previous estimates.

The inherent uncertainty in the resulting mass estimates (particularly for chromium where the concentrations are lower) may explain why the mass estimates demonstrate variability year to year. Starting with second quarter 2014, a 95% margin of error was included in the tables in order to characterize the uncertainty in the mass estimates. The 95% margins of error are calculated based on the standard deviations of the interpolated concentrations and assumed standard deviations for the Qal and UMCf thicknesses. Due to the qualitative evaluation of RI data, the kriging algorithm could not be used to obtain the standard deviation of the interpolated concentrations. Based on professional judgment, we assume a standard deviation for the perchlorate concentration in the Qal of 25%, and for the perchlorate concentration in the UMCf of 33%. We also assume a standard deviation for the Qal thickness of 10% and for the UMCf thickness of 20%.

The thickness of the Qal used in the mass estimate is based on the contact between the alluvium and UMCf in the groundwater model. As part of the Phase III Model Refinement, changes were made to the contact surface between the Qal and the UMCf; therefore, the thickness of the layers used in the mass estimate were changed for the 2015 estimate. This has resulted in some changes in the 2015 mass estimates as compared to 2014, as discussed below.

Another reason that plume mass estimates may vary from year to year is due to on-site sources in the unsaturated zone, which have the potential to contribute significantly to plume mass through leaching. Consistent with the conceptual site model developed as part of the RI/FS Work Plan (ENVIRON 2014b), there are likely continuing sources of both perchlorate and chromium that will contribute to the plume mass over time. The increases in perchlorate concentrations in the IWF following the heavy rains at the end of 2012 represent strong evidence for the existence of such sources in the unsaturated zone. A primary goal of the RI is to investigate potential source areas to better understand the impact of contaminants remaining in the unsaturated zone in order to identify effective long-term remedial alternatives.

The total plume masses as of second quarter 2015 are estimated to be 2,888 \pm 754 tons for perchlorate and 20 \pm 6 tons for chromium. There were increases in all areas in plume mass estimates in the Qal and UMCf for both perchlorate and chromium, except for the chromium estimate on-site in the UMCf, which appears to be due to a smaller area of particularly high concentrations on-site in the shallow zone. These increases in plume mass were caused by a combination of two factors: 1) the evaluation of available shallow groundwater data collected as part of the RI, which has altered the plume interpretation, and 2) the assumed thickness of the layers used in the estimate increased due to the refinement of the contact surface between the Qal and UMCf as a result of the COP subsurface conditions evaluation.

6.4.2 Capture Zone Evaluation and Estimated Mass Flux

Capture zones for each of the well fields were estimated in the shallow, middle, and deep water-bearing zones using forward particle tracking, calculated using MODPATH (Pollock 1994), and using the Phase III Model. Particles were released in the center of each model cell in model layers 1 and 2 (representing the shallow water-bearing zone), layers 3, 4, and 5 (representing the middle water-bearing zone), and layers 6 and 7 (representing the deep water-bearing zone). Capture zones for each well field were defined using an analysis of the particle tracking endpoints.

Based on pumping rates from second quarter 2015, simulated capture zones in the shallow, middle, and deep zones are shown in Figure 31a, Figure 31b, and Figure 31c, respectively. In order to evaluate performance based on this metric, the simulated capture zones are compared to target capture zones, which were defined as the combination of the Site and Downgradient Plume Area, as defined in the RI Work Plan (ENVIRON 2014b) and outlined on Figures 31a, 31b, and 31c. Comparing the target capture zones to the simulated capture zones indicates that the combination of the IWF, AWF and SWF almost completely capture groundwater within the Site and Downgradient Plume Areas, except for a small area between the SWF and Las Vegas Wash, where the perchlorate concentrations are generally less than 10 mg/L (approximately 1.7 mg/L in PC-97 in May 2015), and an area east of the SWF where perchlorate concentrations in groundwater collected from well PC-94 were between 17 and 23 mg/L during the reporting period. These areas are slightly larger than in previous reports because the hydraulic conductivities in the area surrounding the SWF was increased for the Phase III Model. Further refinements to the hydraulic conductivities may occur with additional aquifer testing as part of the RI and the COP.

To further evaluate the performance of each well field, perchlorate mass flux at the IWF, AWF, and SWF were estimated at three transects within the Site and Downgradient Plume Areas, located just upgradient of each of the three respective well fields. The transect lines were drawn perpendicular to the groundwater flow and are shown on Figure 32a. Mass flux was calculated using the methods described in applicable guidance by the Interstate Technology and Regulatory Council (ITRC 2010). The distributions of perchlorate mass flux at the IWF, AWF, and SWF along these transects are shown in Figures 32b, 32c, and 32d, respectively.

Perchlorate mass flux across each transect was calculated differently depending on whether that portion of the transect was inside or outside of the simulated capture zone. The perchlorate mass flux within the capture zone was estimated by averaging the mass loading at each extraction well, which was determined using the average pumping rates for second quarter 2015 and the perchlorate concentration measured in each well in May 2015 .

The estimates of perchlorate mass flux outside of the capture zone at each transect were calculated from modeled flow rates and interpolated concentrations. For each model cell on the transect, the flux was calculated as the product of the average perchlorate concentration for May 2015, modeled groundwater flow rate, model cell width, and the thickness of model layers 1, 2, 3, and 4, which includes the Qal and the estimated saturated thickness of perchlorate-impacted UMCf. Further, it was assumed that perchlorate has not reached the UMCf in the vicinity of the SWF. These assumptions were based on an examination of the vertical distribution of concentrations found at nested wells locations, which are screened in both the Shallow and Middle WBZ.

The overall capture efficiency of each well field was calculated as the ratio of the total captured mass flux to the total mass flux across each transect. The capture efficiencies of the IWF, AWF, and SWF were calculated as 99.9%, 98.1%, and 95.3%, respectively. The results show that during second quarter 2015, an estimated average of 3.5 lbs/day of perchlorate discharged into Las Vegas Wash from the NERT Downgradient Plume Area (as shown on Plate 7). It is important to note this estimated perchlorate mass flux to Las Vegas Wash only accounts for perchlorate passing through the transects within the Downgradient Plume Area and not captured by the well fields. Therefore, any perchlorate outside of the boundary of the NERT Downgradient Plume Area is not accounted for in this estimate. Mass loading to the Las Vegas Wash is greater than this estimate due to additional perchlorate sources outside the NERT Downgradient Plume Area, including AMPAC's perchlorate plume and residual perchlorate from the Lower Ponds Area east of Pabco Road.

Based on an evaluation of concentration trends in observation wells downgradient from the well fields, the capture efficiency may be overestimated for the IWF and AWF. As described in Section 2.2, the elevated perchlorate concentrations observed in well MW-K4 during previous performance periods may have indicated a potential gap in capture at the AWF immediately west of the UMCf ridge. In order to address this gap, well PC-150 was activated in November 2014 as part of the 2013 GWETS Optimization Project. Perchlorate concentrations have decreased considerably in the downgradient wells MW-K4 and PC-144 since September 2014. ART-7B, which is located to the east of the UMCf ridge, was also activated in October 2014. No significant changes in concentration have been observed in downgradient concentrations following activation of extraction well ART-7B. However, the calculated capture efficiency at the AWF has increased from 95% during second quarter 2014 to 98.2% in second quarter 2015.

As requested in NDEP's April 9, 2014 letter on the 2013 Semi-Annual Performance Report (NDEP 2014a), the mass flux across each transect was also estimated using an alternative calculation method, one based only on model-estimated groundwater flow rates and interpolated concentrations. Unlike the baseline method, the alternative method does not use the calculated mass removal rates at extraction wells. Rather, a simple transport model was used to simulate migration of perchlorate in groundwater,

considering advection only. Other transport processes, such as dispersion, diffusion, and external sources or sinks, were not considered. The transport model was developed using MT3DMS (Zheng 2010). Since the perchlorate plume is representative of perchlorate in the shallow water-bearing zone, these concentrations are applied as initial perchlorate concentrations in model layers 1, 2, 3, and 4. However, for the SWF, the mass flux is estimated for layer 1 only, as the concentration of perchlorate in the UMCf is assumed to be 0 in the vicinity of the SWF. For this purpose, the transport model is run for one day only. For comparison, the perchlorate mass captured at each well field using the extraction well mass removal rates (baseline method) and the alternative method is shown below:

 1 From measured flow rates and perchlorate concentrations at each well

The estimate of the mass captured at the three well fields using the alternative method is consistent with the estimate of mass capture using the baseline method. The capture efficiencies of the IWF, AWF, and SWF using the alternate method were calculated as 99.9%, 98.1%, and 95.0%, respectively. The estimated average mass of perchlorate discharged into Las Vegas Wash is equivalent for both methods (3.5 lbs/day in second quarter 2015). While it is Ramboll Environ's opinion that the baseline method, which uses measured mass removal data from extraction wells, is likely to be more accurate than the alternative method, the alternative method provides a good confirmation of the baseline method. The agreement between the baseline and alternative methods also provides validation of the Phase III Model refinements.

6.4.3 Perchlorate Mass Loading to Las Vegas Wash

The water in the Las Vegas Wash is sampled for perchlorate monthly or quarterly at various locations by the GWETS operator (for compliance with the site's NPDES permit) and by SNWA. Currently, perchlorate concentration and mass loading to Las Vegas Wash are reported to NDEP using data from Northshore Road, which is located approximately six river miles downstream of the SWF and just upstream from Lake Mead.

Based on the measured perchlorate concentrations in stream water and corresponding stream flow (at the time of chemical sampling), perchlorate mass loading was estimated at the following three locations: Las Vegas Wasteway (LW8.85), Pabco Road (LW6.05), and Northshore Road (LW0.55). These sampling stations are co-located with United States Geological Survey (USGS) gauging stations and are shown on Figure 33a. Perchlorate mass entering the Las Vegas Wash at any point will include groundwater discharge, as well as other sources (e.g., bank storage, wash gravels). This analysis does not attempt to identify the various sources of perchlorate, but is intended only to identify the general areas where perchlorate may be entering the Las Vegas Wash. Mass loading at the Las Vegas Wasteway stream gauging station, located about 2.8 river miles upstream of the SWF, is used to estimate background levels of perchlorate. Mass loading at Pabco Road can be used to evaluate the portion of the perchlorate mass loading resulting from sources upstream of Pabco Road.

Annual perchlorate mass loading at the three stations (Northshore Road, Pabco Road and Las Vegas Wasteway) for each year (July through June) are shown on Figure 33b and also presented in Table 11. From July 2014 through June 2015, the average perchlorate mass loading was 1.4 lbs/day at Las Vegas Wasteway, 20.1 lbs/day at Pabco Road, and 64.6 lbs/day at Northshore Road. Thus, this analysis indicates that approximately 29% of the mass loading measured at Northshore Road can generally be attributed to mass entering the Las Vegas Wash between the Las Vegas Wasteway and Pabco Road stations, while approximately 67% can be attributed to mass entering Las Vegas Wash between the Pabco Road and Northshore Road stations for this reporting period.

The estimated average perchlorate mass loading to Las Vegas Wash during the reporting period between Las Vegas Wasteway and Pabco Road is 18.7 lbs/d. This number is larger than the estimated 3.5 lbs/d discharged to the Las Vegas Wash through the transects discussed in Section 6.4.2 because it accounts for additional sources of perchlorate loading outside of the NERT Downgradient Plume Area, including AMPAC's perchlorate plume. According to AMPAC's recent monitoring and performance reports, AMPAC's average perchlorate loading to the Athens Drainage Channel was 11 lbs/day from August to December 2014 (AMPAC 2015a, pg. 13) and 12.9 lbs/day from January to May 2015 (AMPAC 2015b, pg 13). AMPAC additionally reported that the perchlorate loading not captured in shallow groundwater was 4 to 5 lbs/day in the second half of 2014 (AMPAC 2015a, pg. 18) and 5 to 6 lbs/day in the first half of 2015 (AMPAC 2015b, pg. 20).

6.4.4 Surface Water and Groundwater Interaction Near the SWF

Because the SWF is located near two surface water bodies (Las Vegas Wash and the COH Bird Viewing Ponds), pumping at the SWF has the potential to induce water originating at these two surface water bodies to flow into the SWF extraction wells. Since the surface water from both the Las Vegas Wash and the COH Bird Viewing Ponds is comprised primarily of treated municipal wastewater effluent, minimization of these inflows would potentially allow a greater percentage of the capacity of the SWF to be used for plume capture.

Recent performance reports evaluated whether surface water is potentially being pulled into the SWF from Las Vegas Wash by comparing groundwater elevations in shallow monitoring wells near the SWF and stream stage at the Pabco Road weir, located approximately 1,000 feet downstream of the SWF (ENVIRON 2014a, 2014c, 2015a). The evaluation presented in the performance reports indicated that by 2007, groundwater elevations in nearby monitoring wells were generally below the stream stage calculated from the stream gauging height recorded by the USGS at Pabco Road weir (USGS $#$ 09419700). However, in 2015 the benchmark for the Pabco Road stream gauge was resurveyed by Ramboll Environ as part of RI field activities. Based on the survey results and additional information received from the USGS, the Pabco Road stage measurements presented previously were adjusted downward by approximately 7 feet.

A comparison of groundwater elevations measured in nearby shallow monitoring wells with the stream stage elevations is shown in Figure 34. Using the relative locations and elevations of the stream stage at Pabco Road weir and groundwater elevations of SNWA wells adjacent to the wash (WMW-6.15S and WMW-6.55S), a slope of 0.0036 feet/foot was calculated, which can be applied as a correction to the stream stage when comparing it to a well upstream of the Pabco Road weir. After adjusting the stream stage, groundwater elevations in the vicinity of the SWF appear to be below the stream stage at PC-94 and above the stream stage at PC-91 and PC-97.

Apart from surface water potentially being pulled into the SWF from the Las Vegas Wash, the SWF appears currently to draw a significant quantity of water from the COH Bird Viewing Ponds, which are located hydraulically upgradient. A region of groundwater containing low concentrations of TDS (<2,500 mg/L) originating at the COH Bird Viewing Ponds extends to the SWF, as shown on the TDS plume map presented (Plate 8). In May 2015, effluent wastewater discharged to the COH Bird Viewing Ponds contained 1,170 mg/L of TDS (COH 2015), which is distinct from the higher TDS concentrations found in groundwater typically ranging from 2,500 to 5,000 mg/L. Thus, TDS values less than 2,500 mg/L in groundwater provide a reliable indicator of the presence of surface water originating from the COH Bird Viewing Ponds. The low TDS region in groundwater extending from the COH Bird Viewing Ponds to the SWF along the expected direction of groundwater flow is strong evidence that the SWF is extracting a significant amount of COH Bird Viewing Pond water.

To further evaluate the trends suggested by TDS concentrations and groundwater elevations near Las Vegas Wash, additional analyses were performed in February 2014 on samples collected from seven wells in or near the SWF (PC-62, PC-91, PC-97, PC-117, PC-119, PC-121, and PC-133) and three wells at the AWF (MW-K4, ART-4A, and ART-9) (ENVIRON 2014c). The samples were analyzed for certain geochemical parameters not typically monitored as part of the groundwater monitoring program (e.g., total suspended solids [TSS], chloride, fluoride, sulfate, ortho-phosphate, ammonia, nitrate, nitrite, and total alkalinity). Additional surface water samples were collected by Ramboll Environ in April 2015 from the COH Bird Viewing Ponds. Data from both sampling events were then compared to samples collected from stations LW5.5, LW6.05, and LW8.85 in Las Vegas Wash by the Bureau of Reclamation in 2012 (Bureau of Reclamation 2014).

An initial analysis of these data suggests that three distinct water types (groundwater, Las Vegas Wash water, and water from the COH Bird Viewing Ponds) are likely mixing at the SWF. Figure 35a shows a complete Piper diagram of these cation-anion data, while Figure 35b presents a modified version of the upper portion of the Piper diagram that shows the water type distinctions more clearly. The relative composition of major ions shown in Figure 35b suggests that the perchlorate plume's relatively high TDS groundwater, which is represented by ART-9, ART-4A, and MW-K4, is chemically distinct from the closely grouped water samples of relatively low TDS water collected from Las Vegas Wash (LW 5.5, LW 6.05, and LW 8.85) and the COH Bird Viewing Ponds (BP-01 through BP-09). In addition, the distribution of data in Figure 35b indicates water from Las Vegas Wash is chemically distinct from water from the COH Bird Viewing Ponds. The distribution of data from wells in or near the SWF (PC-62, PC-91, PC-97, PC-117, PC-119,

PC-121, and PC-133) suggests that groundwater extracted from the well field is from a combination of these three distinct sources.

The amount of water originating at the COH Bird Viewing Ponds and subsequently captured by the SWF was quantified using the Phase III Model presented as Attachment A. Under second quarter 2015 conditions, the Phase III Model indicates that approximately 40% of water extracted at the SWF originates from the COH Bird Viewing Ponds (ENVIRON 2015b). Results of a simple mixing calculation between surface water (either from the COH Bird Viewing Ponds or the Las Vegas Wash) and groundwater using TDS as an indicator compound, originally presented as part of the 2013 GWETS Optimization Report (ENVIRON 2015b), supported the findings of the model. The calculations suggested that wells in the western portion of the SWF (wells PC-119, PC-118, and PC-115R) are pumping significant amounts of water (up to about 80%) from nearby surface water sources. Based on the location of the wells, it is likely that the primary source of this water is the COH Bird Viewing Ponds. In the middle portion of the SWF (wells PC-99R2/R3 and PC-116R) approximately 20-40% of the pumped water is likely from nearby surface water sources. In the eastern portion of the well field (wells PC-117 and PC-133), the portion of the water coming from nearby surface water sources likely ranges from approximately 40-60%, which may be due to surface water drawn in from the Las Vegas Wash (ENVIRON 2015b). The use of TDS alone as a tracer cannot differentiate COH Bird Viewing Pond water from Las Vegas Wash water.

In response to the 2014 Semi-Annual Remedial Performance Report, NDEP requested that the Trust refine estimates of the sources of SWF flow by quantifying individual contributions of the Las Vegas Wash and the COH Bird Viewing Ponds to SWF extraction. Ramboll Environ is currently developing an approach for additional sampling of the SWF, the Las Vegas Wash, and the COH Bird Viewing Ponds. Conductance, temperature, and depth (CTD) loggers will also be deployed in the vicinity of the SWF and the Las Vegas Wash to address data gaps prohibiting adequate quantification of flows. This work is currently scheduled for first quarter 2016 and will be used to support the Phase 4 groundwater modeling efforts.

6.4.5 Environmental Footprint

Based on information compiled for the July 2014 to June 2015 environmental footprint analysis, which documents energy and materials used at the Site, the GWETS used approximately 3.9 million kilowatt hours per year (kWh/yr) and the wells and pump stations used approximately 1.4 million kWh/yr.^{[22](#page-44-0)} Monthly energy use by the GWETS varied from 301,807 to 335,288 kWh between July 2014 and June 2015. Monthly use by the wells and lift stations varied from 104,020 to 127,120 kWh during the same period. During the July 2014 to June 2015 performance period, approximately 10.3 kWh of electricity were used for each pound of perchlorate removed, which is consistent with the 10.4 kWh of electricity used per pound of perchlorate removed from July 2013 to June 2014.

 22 This information was initially requested by NDEP and the USEPA as part of the 2011-2012 Footprint Analysis (ENVIRON 2013b). \overline{a}

6.4.6 GW-11's Operation as an Equalization Basin

As previously discussed, GW-11's use as an equalization basin was temporarily halted on August 6, 2014 after plugging of filtration equipment. During the current reporting period, modifications to the intake filtration system enabled GW-11 to begin operating as an equalization basin on January 6, 2015. The system was taken offline again from January 29 to February 4, 2015 to perform additional modifications to the filtration system and from April 8 to April 10, 2015 during installation of the new GW-11 influent flow meter and sample tap as part of the Enhanced Operational Metrics project. In their April 9, 2014 comments on the 2013 Semi-Annual Performance Report (NDEP 2014a), NDEP requested a full analytical assessment (e.g., perchlorate, chlorate, nitrate, chloride, sulfate, ammonia, phosphorus, calcium, iron, total chromium, hexavalent chromium, TDS, TSS, and pH) of water in the GW-11 pond prior to its use as an equalization basin. Envirogen collected an initial composite sample of GW-11 water on March 27, 2014, the day GW-11 began operating as an equalization basin. 23 The initial sample was analyzed for all of the requested analytes with the exception of ammonia.

In ENVIRON's June 30, 2014 response to NDEP comments on the 2013 Semi-Annual Performance Report, ENVIRON (now known as Ramboll Environ) indicated that GW-11 would be monitored for the requested analytes and other parameters (water volume, level, and flow rate) on a monthly basis and reported in the Annual and Semi-Annual Performance Reports. As shown in Table 12, GW-11 water volume and level were monitored on an approximately weekly to bi-weekly basis during the reporting period and average influent and effluent flow were calculated on a monthly basis. Estimated evaporation rates for GW-11, which were calculated using the pond's surface area and published pan evaporation rates (Shevenell 1996), were also included to more fully explain changes in GW-11's volume (e.g., decreasing water volume despite greater influent than effluent flow). The total volume of water in GW-11 increased by approximately 12.6 million gallons during the reporting period from a low of approximately 35.8 million gallons in early July 2014 to 48.4 million gallons in late June 2015, reaching a maximum volume of 49.8 million gallons in March 2015. GW-11 was operating as an equalization basin from January 2015 through the end of the reporting period, causing an increase in influent flow during this timeframe. Additional influent to the pond included diversions of FBR effluent and well field influent, as well as backwash from various maintenance operations.

As presented in Table 13, between March and December 2014 Envirogen collected approximately monthly single-point grab samples via the GW-11 effluent piping, which were analyzed for a reduced list of analytes (perchlorate, chlorate, nitrate, total chromium, and hexavalent chromium). In late July 2014, Tetra Tech^{[24](#page-45-1)} initiated collection of four-point composite samples which were analyzed for the full suite of requested analytes. An initial sample was collected on July 25, 2014 via bailer, however, it was determined that permanent sampling tubes needed to be installed to address safety

 23 GW-11 monitoring was originally requested by NDEP via email on March 26, 2014, prior to start-up of GW-11 as an equalization basin (NDEP 2014a).

²⁴ Starting in May 2014, Tetra Tech began overseeing Envirogen's groundwater sampling activities and operation of the GWETS.

concerns related to collecting samples from the pond corners. Once the sampling tubes were installed in early September, sampling was re-initiated with a four-point composite sample collected from the pond corners on September 4, 2014, and analyzed for the full list of requested analytes. GW-11 sampling was interrupted in August 2014 after the pond's use as an equalization basin was temporary halted. Monthly sampling for the full analyte list was reinitiated after GW-11 began operating as an equalization basin on January 6, 2015. The perchlorate mass in GW-11 presented in Table 14 was calculated using perchlorate concentration data (as presented in Table 12) and GW-11 pond volume data (presented in Table 13). Measured perchlorate concentrations ranged from 44 mg/L to 130 mg/L during the reporting period, with the lowest concentrations observed from November 2014 to January 2015. As noted above, GW-11 was not operating as an equalization basin from August 2014 to January 2015. Based on discussions with Envirogen, it is believed that these lower concentrations are due to inputs of relatively clean water from effluent diversions and backwashing events during this time frame compounded by the lack of inflow of perchlorate-containing groundwater from the well fields.

In addition to regular analytical monitoring of GW-11, Tetra Tech continues to evaluate the integrity of GW-11 leak detection pipes and the primary and secondary pond liners, as described in the monthly GWETS Operation Reports submitted by Tetra Tech to NDEP. In May 2015, leakage rate tests were completed in each of the GW-11 corner sump wells. Recorded daily leakage rates ranged from 32.2 to 68.2 gallons/acre-day. Dye Tracer tests initiated in April indicated the integrity of the secondary liner appears to be sound. On June 8, 2015, the NDEP Bureau of Water Pollution Control (BWPC) directed the Trust to develop a plan to identify the source of leakage in GW-11 and address the leakage should the rate exceed 250 gallons/acre-day. A work plan to address this request entitled "GW-11 Pond Liner System Leak Location and Repair Work Plan" was submitted to the BWPC on June 29, 2015.

6.4.7 Analysis of Barrier Wall Performance

Performance of the barrier wall at the IWF was evaluated using groundwater elevation data from wells immediately upgradient and downgradient of the barrier, as well as perchlorate concentration data in these same wells. Groundwater elevation data were plotted over time for the same paired wells presented in Figures 2a through 2f. As shown on Figures 36a through 36f, perchlorate concentration data have been added to these hydrographs for the downgradient wells and for additional extraction wells upgradient of the barrier wall. These data are presented in Figures 36a through 36f.

The primary measure of the barrier wall's effectiveness is the change in potentiometric surface across the wall (i.e., the difference in water elevations between the upgradient and downgradient wells). During this period of performance, the elevation difference ranged from 5 to 12 feet, with the lowest elevation difference on the west side of the barrier wall near the M-167/M-69 well pair (Figure 36a) and the highest elevation difference on the east side of the barrier wall near the M-67/M-73 well pair (Figure 36e). While water elevations vary in response to precipitation events in the vicinity of the IWF, the relative elevations in the well pairs has remained reasonably constant (i.e., the groundwater elevations in the upgradient and downgradient wells rise and fall in

tandem). Prior to September 2008, the elevation differences were more variable due to the operation of the recharge trenches.

Although the hydraulic data suggest that the barrier wall is an effective barrier to groundwater flow, concentrations in downgradient wells have increased since the end of 2012, most notably in M-69, M-70, and M-71. The increases in concentration in downgradient wells follow similar trends as those in the upgradient wells. As discussed in the 2012-2013 Annual and 2013 Semi-Annual Reports, these increased concentrations were believed to be related to mobilization of soil-bound perchlorate as a result of heavy rains in the fall and winter of 2012 (ENVIRON 2013c; ENVIRON 2014a).

An initial evaluation of barrier wall effectiveness included in the 2013-2014 Annual Performance Report concluded that although the concentration data is consistent with leakage past the wall, the hydraulic data do not support this interpretation. For leakage to occur, it is expected that there first be a hydraulic response (an increase in head) in the upgradient wells followed by a similar hydraulic response in the downgradient wells. In fact, the data show the opposite—the hydraulic response is seen first in the downgradient wells.

During the current report period perchlorate concentrations and groundwater elevations have generally continued to decrease on both sides of the wall, indicating a gradual return to conditions that existed prior to November 2012. Water levels increased on the east end of the barrier wall during 2014, although water levels in this area decreased slightly at the end of the current reporting period. The localized increase in water levels is likely due to emplacement of TIMET's barrier wall to the east in March 2014 (GEI 2015). The performance of the barrier wall as part of the overall long-term remedy will be evaluated, including the potential to re-initiate artificial recharge via trenches or other means, as part of the Feasibility Study.

6.5 Summary of GWETS Performance Evaluation

A summary of the performance metrics is shown in Table 15. The performance metrics for GWETS described above will be used to adjust the operation of the GWETS to more effectively and efficiently meet the performance objectives during the COP. The assumptions used in calculation of the metrics, which are described throughout Section 6.4, were also reviewed as part of the Phase III Model Refinement in Attachment A

6.6 Continuous Optimization Program

In January 2015, NDEP required the Trust to initiate a COP to enhance the performance and efficiency of the GWETS (NDEP 2015a). In support of the COP, various data compilation and evaluation tasks have been initiated, including a subsurface conditions evaluation, a hydrogeologic evaluation, and an evaluation of extraction system infrastructure, capacity, and technology.

In May through August 2015, Ramboll Environ conducted a subsurface conditions evaluation and a hydrogeologic evaluation in order to compile and evaluate pertinent historical data regarding hydrogeologic conditions at the Site and in the Downgradient Plume Area. The subsurface conditions evaluation included the compilation of extensive historical data regarding soil boring and well construction details, and the refinement of the interpretation of subsurface conditions, including updated interpretations of the paleochannel configuration and the contact surface between the UMCf and the Qal. The hydrogeologic evaluation included compilation of previously conducted aquifer testing in each groundwater bearing zone, analysis of the variance of hydraulic conductivity across each extraction well field, and an evaluation of previous capture zone analyses to identify limitations or constraints that would affect the reliability of capture zone results. Based on these evaluations, additional recommendations have been made to address identified data gaps. The groundwater model has also been refined based on the conclusions of these evaluations, as discussed in Attachment A.

In August 2015, Tetra Tech submitted the Infrastructure Audit and Data Accessibility Report for the GWETS on behalf of the Trust to NDEP (Tetra Tech 2015d). This report reviewed potential limitations to utilizing the full capacity of the GWETS, including the influent and effluent pipelines; the existing NPDES permit; the pumping capacity of Lift Stations 1, 2, and 3; and the GWTP hydraulic and mass loading capacity. Recommendations for near-term implementation were made to address potential deficiencies, including the establishment of a well pump maintenance program to improve accuracy of pumping records, the installation of a larger backup pump at Lift Station 2 to accommodate both SWF and AWF flows, evaluation of the effluent pump and pipeline system to identify physical limitations, installation of equipment to improve GW-11 inflow and pond stage measurements, and installation of network infrastructure to allow for accessing recent GWETS data via the web.

The conclusions drawn from these efforts have been incorporated into the Phase III Model Refinement, as described in Attachment A, and will also inform future groundwater modeling efforts, including development of the transient Phase 5 Model. Additional recommendations regarding well field equipment, lift station pumps, the effluent pump station, pipelines, the GWTP, and the FBR treatment plant will be evaluated during optimization of the well field extraction rates being performed as part of the COP. Data compilation from the COP will also be incorporated into three-dimensional (3D) visualization tools, which will be used to further refine and understand the conceptual site model. Furthermore, NERT is in the process of adjusting groundwater extraction rates at the AWF in order to remove additional perchlorate from the environment as part of the COP.

7. CONCLUSIONS

The GWETS consists of three groundwater capture well fields: the IWF, the AWF, and the SWF. The IWF coupled with the barrier wall provides capture of the highest concentrations of perchlorate and chromium at the Site and significantly reduces the amount of perchlorate and chromium in downgradient groundwater. The off-site AWF, located approximately 8,200 feet downgradient of the IWF, has operated since October 2002. The AWF captures significantly lower concentrations of both perchlorate and chromium, but operates at higher extraction rates compared with the IWF and contributes significantly to the overall mass of perchlorate removed from the environment and mitigates its migration in groundwater. The SWF, located over a broad alluvium channel in close proximity to Las Vegas Wash, operates at the highest flow rate (average of 536.0 gpm between July 2014 and June 2015) compared with the IWF (68.7 gpm) and the AWF (285.6 gpm), but captures groundwater containing significantly lower perchlorate concentrations.

Treatment of chromium-contaminated groundwater captured by the IWF occurs via the on-site GWTP, which chemically reduces hexavalent chromium and removes total chromium. Treatment of perchlorate-contaminated groundwater from all well fields occurs via the on-site FBRs, which biologically remove perchlorate as well as chlorate and nitrate. The FBRs also remove lesser amounts of residual chromium.

For the 12-month period ending in June 2015, the capture of chromium-contaminated groundwater at the IWF, and treatment at the on-site GWTP, has removed approximately 2,270 pounds of chromium. Adding the approximately 210 pounds of chromium removed by the FBRs for the same period, a total of approximately 2,480 pounds of chromium were removed from groundwater between July 2014 and June 2015.

For the same 12-month period, the capture of perchlorate-contaminated groundwater from all three well fields, and biological treatment in the on-site FBRs, has removed a total of approximately 508,200 pounds of perchlorate from the environment. This was a 3.1% decrease from 524,500 pounds of perchlorate removed during 12-month period ending in June 2014. The decrease in removal is primarily the result of decreasing average perchlorate concentrations, particularly in groundwater extracted from the AWF.

The performance metrics developed as part of the 2013 GWETS Optimization Project and described in Section 6 will continue to be used for quantitatively evaluating performance of the GWETS on a comparative basis moving forward. As discussed in Section 6.4.1, the plume interpretation was altered this year to incorporate available shallow groundwater data from the RI and information from the COP subsurface evaluations. As a result, plume mass estimates have changed considerably from previous years. Therefore, the current mass estimates (although more accurate) are not comparable to previous estimates. The COP is being implemented and will be summarized in subsequent performance reports, as described in Section 6.6.

During the current reporting period, GW-11 was taken out of service as an equalization basin on August 6, 2014 due to problems with filtration. Modifications to the filtration

system were implemented in January 2015, at which point GW-11 began operating again as an equalization basin through the end of the reporting period.

Following construction and installation of new pipelines at the AWF, wells ART-7B and PC-150 began operating as extraction wells in October and November, 2014, respectively. Additional optimization and well testing work completed as part of the 2013 GWETS Optimization Project is now complete and was described in Attachment A of the 2014 Semi-Annual Performance Report (ENVIRON 2015b). Future optimization efforts will be performed as part of the COP. Currently, an initial evaluation and optimization of the AWF is being implemented at the AWF, as described in Section 6.4.

The distribution of chromium, perchlorate, and TDS has been evaluated by considering data collected as part of the ongoing RI in addition to data obtained through the groundwater monitoring program. As discussed in Section 4, this evaluation has changed the configuration of the perchlorate plume compared to prior interpretations. Based on this information it appears that the AWF is capturing portions of the AMPAC plume. Downgradient groundwater conditions will be further examined to determine the extent of contamination migrating from the NERT site.

8. PROPOSED FUTURE ACTIVITIES

With the exception of the RI activities associated with the Unit 4 and 5 Buildings, field activities related to the initial phase of the RI have been completed. Information from the groundwater, soil, and soil gas sampling programs will be incorporated into an interim RI technical memorandum and ultimately, the RI Report. Additional field investigations may be recommended following RI data evaluation. Ramboll Environ also anticipates refining the steady state groundwater model (Phase 4 model) and submitting it with the 2015 Semi-Annual Remedial Performance Report in April 2016.

As a number of new groundwater wells have been installed during the RI to address data gaps in the understanding of groundwater conditions at the Site and in the NERT Downgradient Plume Area, a logical next step is to evaluate and determine which of these new wells will be incorporated into the groundwater monitoring program. Therefore, during first quarter 2016, Ramboll Environ anticipates performing a comprehensive review of the groundwater monitoring program in an effort to address data gaps, enhance data quality, reduce data redundancies, and optimize the monitoring well network. The overall goal of the review will be to offer recommendations that will result in an improved groundwater monitoring program that is aligned with our current understanding of the conceptual site model and that is optimized to reduce inefficiencies. Evaluation of newly-acquired RI data will provide the basis for potential recommendations to expand the list of analytes (and where to do so) and whether sampling methods need to be changed. A report describing the findings from this review will be included as an attachment to the forthcoming 2015 Semi-Annual Remedial Performance Report.

Also anticipated in first quarter 2016 is the implementation of sampling of the SWF, the Las Vegas Wash, and the COH Bird Viewing Ponds for certain geochemical parameters in order to address NDEP's request for quantification of source water flows into the SWF intended to support the Phase 4 groundwater modeling efforts. CTD loggers will also be deployed in the vicinity of the SWF and the Las Vegas Wash and monitored telemetrically to address known data gaps prohibiting adequate quantification of flows. The findings of this investigation will be discussed in the 2015 Semi-Annual Remedial Performance Report.

Other proposed future activities include implementation of various tasks in support of the COP, including further evaluation of hydrogeologic data, refinement of the subsurface geologic model, development of three-dimensional visualization tools, development of optimized extraction rates using the model, and retrofits to existing GWETS equipment, as described in Section 6.6. The implementation of the Enhanced Operational Metrics Work Plan (Tetra Tech 2014a) is currently underway, which will bring online enhanced flow and water level measurement and control capabilities. The data resulting from the enhanced operation metrics will be reported as part of the ongoing monthly GWETS reporting.

In addition to the ongoing groundwater monitoring program and operation of the GWETS by NERT, NDEP is planning a downgradient investigation expanding upon the NERT RI. The NDEP downgradient RI is intended to determine the extent of elevated constituents migrating from the Site outside of the Downgradient Plume Area included within the

scope of the NERT RI. It is currently anticipated that the results of the NERT and NDEP RIs will be reported in a single RI Report.

9. REFERENCES

- American Pacific Corporation (AMPAC), 2015a. BCA Semi-Annual Monitoring and Performance Report, July 1 to December 31, 2014. February 20.
- AMPAC, 2015b. BCA Semi-Annual/Annual Monitoring and Performance Report, January 1 to June 30, 2015.
- Bureau of Reclamation, 2014. Las Vegas Wash Water Quality Monitoring Program 2012 Report: A Water Quality Assessment. August.City of Henderson (COH), 2015. May 2015 City of Henderson Water Quality Laboratory, Bird Viewing Preserve. Provided October 5, 2015.
- ENVIRON International Corporation (ENVIRON), 2012. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2011 – June 2012. August 31. NDEP approved July 2, 2013.
- ENVIRON, 2013a. Semi-Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2012 – December 2012. March 1.
- ENVIRON, 2013b. Inventory of Resources, Materials, Activities, and Services for Environmental Footprint Analysis Groundwater Removal Action; NERT Site; Henderson, Nevada. August 8. Under NDEP review.
- ENVIRON, 2013c. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2012 – June 2013. August 30. NDEP approved October 10, 2013.
- ENVIRON, 2013d. 2013 GWETS Optimization Project Work Plan, Revision 1, Nevada Environmental Response Trust Site; Henderson, Nevada. November 22. NDEP approved December 3, 2013.
- ENVIRON, 2014a. Semi-Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2013 – December 2013. February 27. NDEP approved August 7, 2014.
- ENVIRON, 2014b. Remedial Investigation and Feasibility Study Work Plan, Revision 2, Nevada Environmental Response Trust Site; Henderson, Nevada. June 19. NDEP approved July 2, 2014.
- ENVIRON, 2014c. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2013 – June 2014. October 31. NDEP approved on December 26, 2014.
- ENVIRON, 2015a. Semi-Annual Remedial Performance Report for Chromium and Perchlorate; Nevada Environmental Response Trust Site; Henderson, Nevada; July 2014 – December 2014. April 30. NDEP approved May 20, 2015.
- ENVIRON, 2015b. 2013 GWETS Optimization Project Report; Nevada Environmental Response Trust Site; Henderson, Nevada. April 30. NDEP approved May 20, 2015.
- GEI Consultants, Inc. (GEI), 2015. Groundwater Extraction and Treatment System Operations, Maintenance and Performance Report; Quarterly Report. February 27.
- Interstate Technology & Regulatory Council (ITRC), 2010. Use and Measurement of Mass Flux and Mass Discharge. August.
- Nevada Environmental Response Trust (NERT), 2015. Las Vegas Wash Seep Interim Measures Report. April 7. Approved by NDEP on April 9, 2015.
- Northgate Environmental Management, Inc. (Northgate), 2010. Capture Zone Evaluation Report, Henderson, Nevada. December 10. ENVIRON resubmitted the NERT Site groundwater model on February 21, 2013. NDEP approved April 4, 2013.
- Nevada Division of Environmental Protection (NDEP), 2013a. Nevada Division of Environmental Protection (NDEP) Response to: Hydrogeologic Flow Model, Supporting Documentation, and Response to Comments on the Model for the Nevada Environmental Response Trust Site; Henderson, Nevada; Dated April 25, 2012 and updated February 21, 2013. April 4.
- NDEP, 2013b. Nevada Division of Environmental Protection (NDEP) Response to: Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust, Henderson, Nevada, July 2012 – June 2013. October 10.
- NDEP, 2013c. Nevada Division of Environmental Protection (NDEP) Response to: 2013 GWETS Optimization Project Work Plan, Revision 1; Dated November 22, 2013. December 3.
- NDEP, 2014a. Email Requesting GW-11 Pond Sampling. March 26.
- NDEP, 2014b. Nevada Division of Environmental Protection (NDEP) Response to: Semi-Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site, Henderson, Nevada; Dated February 28, 2014. April 9.
- NDEP, 2015a. Requirements for Continued Optimization of GWETS System. January 7.
- NDEP, 2015b. Seep Interim Measures Report Approval. April 9.
- Pollock, D.W., 1994. User's Guide for MODPATH/MODPATH-PLOT, Version 3: A particle tracking post-processing package for MODFLOW, the U.S. Geological Survey finite difference ground-water flow model: U.S. Geological Survey Open-File Report 94- 464, 6 Ch.
- RCI Engineering, 2010. Technical drainage study for Tronox soil remediation treatment basins. RCI Engineering, Las Vegas, NV. October 2010.
- Shevenell, Lisa, 1996. Nevada Bureau of Mines and Geology, Report 48: Statewide Potential Evapotranspiration Maps for Nevada.
- Tetra Tech, Inc. (Tetra Tech), 2014a. GWETS Enhanced Operational Metrics Proposal, Nevada Environmental Response Trust Site; Henderson, Nevada. August 20.
- Tetra Tech, 2014b. Personal Communication from Frank John's on the 2013-2014 Annual Performance Report for Chromium and Perchlorate. October 31.
- Tetra Tech, 2015a. Groundwater Bioremediation Pilot Test Work Plan, Nevada Environmental Response Trust Site; Henderson, Nevada. January 6.

Tetra Tech, 2015b. November 2014 NDEP GWETS Metrics. January 23.

Tetra Tech, 2015c. June 2015 NDEP GWETS Metrics. July 20.

- Tetra Tech, 2015d. Infrastructure Audit and Data Accessibility Report; Nevada Environmental Reponse Trust; Henderson, Nevada. August 25.
- United States Environmental Protection Agency (USEPA), 2008. A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems: U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/003.

Zheng, C., 2010, MT3DMS v5.3 Supplemental User's Guide, Department of Geological Sciences, University of Alabama, Tuscaloosa, Alabama.

Annual Remedial Performance Report For Chromium and Perchlorate Nevada Environmental Response Trust Site Henderson, Nevada

TABLES

TABLE 1: INTERCEPTOR WELL FIELD DISCHARGE RATES

Nevada Environmental Response Trust Site Henderson, Nevada

Notes:

Pumping rates are presented as annual averages.

- = Well not pumping

gpm = gallons per minute

Qal = Quaternary Alluvium

UMCf = Upper Muddy Creek Formation (first fine-grained unit)

TABLE 2: ATHENS ROAD WELL FIELD DISCHARGE RATES

Nevada Environmental Response Trust Site Henderson, Nevada

Notes:

Pumping rates are presented as annual averages.

- = Well not pumping

ART-1, 2, 3, 4, 7, and 8 have adjacent recovery wells - "Buddy Wells" - designated by the letter "A".

¹ART-7B and PC-150 were activated as part of the 2013 GWETS Optimization project; ART-7B began pumping in October 2014 and PC-150 began pumping in November 2014.

²Starting in September 2006, ART-9 replaced the pumping of ART-6/6A due to the low water levels in that well pair. The electrical and plumbing system from ART-6A was removed and is being used in ART-9.

gpm = gallons per minute

Qal = Quaternary Alluvium

TABLE 3: SEEP WELL FIELD DISCHARGE RATES

Nevada Environmental Response Trust Site Henderson, Nevada

Notes:

Pumping rates are presented as annual averages.

¹Wells PC-99R2 and PC-99R3 are connected and operate as a single pumping well.

²Wells PC-120 and PC-121 have not been continuously pumped since October 2005 due to their low perchlorate removal efficiencies and because they are located at the end of the well line in the shallowest portion of the subsurface alluvial channel.

gpm = gallons per minute

Qal = Quaternary Alluvium

TABLE 4: MONTHLY WELL FIELD DISCHARGE RATES, JULY 2014 - JUNE 2015

Nevada Environmental Response Trust Site

Henderson, Nevada

TABLE 4: MONTHLY WELL FIELD DISCHARGE RATES, JULY 2014 - JUNE 2015

Nevada Environmental Response Trust Site

Henderson, Nevada

¹Wells PC-120 and PC-121 have not been continuously pumped since October 2005 due to their low perchlorate removal efficiencies and because they are located at the end of the well line in the shallowest portion of the subsurface alluvial channel.

Page 2 of 2 Ramboll Environ

Notes:

Pumping rates are presented as monthly averages.

gpm = gallons per minute

- = Well not pumping

TABLE 5: CHROMIUM TREATMENT DATA FOR THE GWTP, JULY 2014 - JUNE 2015 Nevada Environmental Response Trust Site Henderson, Nevada

Estimated Chromium Removed by GWTP: 2,270 Estimated Chromium Removed by FBRs: 210 Estimated Total Chromium Removed: 2,480

Notes:

All values presented in Table 5 for January - June 2015 were calculated by Tetra Tech. Estimated removal rates are rounded to the nearest 10 pounds.

 1 Hexavalent chromium is used as a surrogate for total chromium in inflow calculations for July -December 2014.

 2 Treated Outflow is directed to Bioplant Equalization Area and Carbon Treatment before being fed to the Fluidized Bed Reactors (FBRs).

 $Cr =$ chromium

FBR = fluidized bed reactor

GWTP = groundwater treatment plant

gpm = gallons per minute

lbs = pounds

mg/L = milligrams per liter

Nevada Environmental Response Trust Site Henderson, Nevada TABLE 6: WEEKLY CHROMIUM IN FBR INFLUENT AND EFFLUENT, JULY 2014- JUNE 2015

Nevada Environmental Response Trust Site Henderson, Nevada TABLE 6: WEEKLY CHROMIUM IN FBR INFLUENT AND EFFLUENT, JULY 2014- JUNE 2015

Nevada Environmental Response Trust Site Henderson, Nevada TABLE 6: WEEKLY CHROMIUM IN FBR INFLUENT AND EFFLUENT, JULY 2014- JUNE 2015

Notes:

-- = No Sample

 $B =$ Compound was found in the blank and sample.

FBR = Fluidized Bed Reactor

 $H =$ sample analyzed beyond hold time

J = Estimated Concentration

mg/L = milligrams per liter

SQL = Sample Quantitation Limit

TABLE 7: PERCHLORATE REMOVED FROM THE ENVIRONMENT

Nevada Environmental Response Trust Site Henderson, Nevada

TABLE 7: PERCHLORATE REMOVED FROM THE ENVIRONMENT

Interceptor Well Field (lbs/day) Athens Road Well Field (lbs/day) Seep Wells and Seep (lbs/day) Total (lbs/day) Total Pounds Removed (per month) Total Tons Removed (per month) Interceptor Well Field (gpm) Athens Road Well Field (gpm) Seep Well Field (gpm) Total (gpm) Interceptor Well Field (mg/L) Athens Road Well Field (mg/L) Month | (Ibs/day) | (Ibs/day) | (Ibs/day) | (Ibs/day) | (per-month) | (per-month) | (gpm) | (gpm) | (gpm) | (mg/L) **Perchlorate Removal Rate Average Perchloration Rate Extraction Rate Extraction** Rate **Average Perchloration** Sep 2006 | 1,064 | 768 | 157 | 1,989 | 59,674 | 29.8 | 66.2 | 251.5 | 656.4 | 974.0 | 1,341 | 255 | 20.0 | 170 Oct 2006 | 1,018 | 778 | 134 | 1,930 | 59,824 | 29.9 | 66.4 | 254.7 | 649.0 | 970.0 | 1,279 | 255 | 17.3 | 166 Nov 2006 | 867 | 724 | 102 | 1,694 | 50,809 | 25.4 | 63.9 | 258.0 | 524.0 | 845.8 | 1,133 | 234 | 16.3 | 167 Dec 2006 | 870 | 745 | 121 | 1,736 | 53,818 | 26.9 | 64.6 | 253.4 | 629.2 | 947.1 | 1,124 | 245 | 16.0 | 153 Jan 2007 | 948 | 786 | 98 | 1,831 | 56,775 | 28.4 | 66.1 | 256.2 | 638.2 | 960.4 | 1,197 | 256 | 12.8 | 159 Feb 2007 | 871 | 736 | 91 | 1,697 | 47,520 | 23.8 | 68.5 | 265.6 | 657.5 | 991.6 | 1,060 | 231 | 11.5 | 143 Mar 2007 | 915 | 689 | 88 | 1,692 | 52,454 | 26.2 | 68.4 | 259.0 | 601.3 | 928.6 | 1,116 | 222 | 12.2 | 152 Apr 2007 | 896 | 692 | 90 | 1,678 | 50,351 | 25.2 | 68.1 | 257.2 | 631.5 | 956.8 | 1,098 | 225 | 11.9 | 146 May 2007 | 890 | 679 | 100 | 1,669 | 51,734 | 25.9 | 66.2 | 259.1 | 660.5 | 985.8 | 1,120 | 219 | 12.6 | 141 Jun 2007 | 832 | 642 | 91 | 1,565 | 46,959 | 23.5 | 64.3 | 258.5 | 673.7 | 996.5 | 1,079 | 207 | 11.3 | 131 Jul 2007 | 912 | 659 | 67 | 1,638 | 50,785 | 25.4 | 63.7 | 257.8 | 656.7 | 978.3 | 1,193 | 213 | 8.6 | 140 Aug 2007 | 840 | 632 | 55 | 1,527 | 47,329 | 23.7 | 61.2 | 258.5 | 611.0 | 930.7 | 1,145 | 204 | 7.5 | 137 Sep 2007 | 842 | 631 | 53 | 1,526 | 45,794 | 22.9 | 59.2 | 251.1 | 605.2 | 915.5 | 1,187 | 210 | 7.4 | 139 Oct 2007 | 841 | 686 | 53 | 1,580 | 48,973 | 24.5 | 59.4 | 264.5 | 617.0 | 940.9 | 1,181 | 216 | 7.2 | 140 Nov 2007 | 762 | 675 | 55 | 1,493 | 44,782 | 22.4 | 57.3 | 264.1 | 622.9 | 944.3 | 1,110 | 213 | 7.4 | 132 Dec 2007 | 742 | 655 | 60 | 1,456 | 45,134 | 22.6 | 55.4 | 264.1 | 627.6 | 947.1 | 1,117 | 207 | 7.9 | 128 Jan 2008 | 873 | 630 | 58 | 1,562 | 48,410 | 24.2 | 56.5 | 262.9 | 631.2 | 950.7 | 1,289 | 200 | 7.6 | 137 Feb 2008 | 818 | 634 | 61 | 1,513 | 43,878 | 21.9 | 59.1 | 262.2 | 608.9 | 930.3 | 1,154 | 202 | 8.3 | 136 Mar 2008 | 870 | 666 | 60 | 1,595 | 49,460 | 24.7 | 61.6 | 265.0 | 614.0 | 940.6 | 1,178 | 210 | 8.1 | 141 Apr 2008 | 830 | 656 | 54 | 1,540 | 46,196 | 23.1 | 61.9 | 268.1 | 623.1 | 953.1 | 1,118 | 204 | 7.3 | 135 May 2008 | 721 | 627 | 46 | 1,394 | 43,222 | 21.6 | 60.6 | 266.5 | 618.8 | 945.9 | 993 | 196 | 6.2 | 123 Jun 2008 | 732 | 637 | 44 | 1,413 | 42,393 | 21.2 | 61.0 | 271.5 | 630.3 | 962.8 | 1,001 | 196 | 5.8 | 122 Jul 2008 | 817 | 673 | 54 | 1,544 | 47,872 | 23.9 | 63.4 | 273.5 | 618.5 | 955.4 | 1,076 | 205 | 7.3 | 135 Aug 2008 | 945 | 678 | 59 | 1,682 | 52,153 | 26.1 | 65.7 | 276.5 | 585.1 | 927.3 | 1,201 | 205 | 8.4 151 Sep 2008 | 798 | 635 | 56 | 1,489 | 44,670 | 22.3 | 65.4 | 275.7 | 589.9 | 931.0 | 1,018 | 192 | 7.9 | 133 Oct 2008 | 801 | 626 | 51 | 1,477 | 45,791 | 22.9 | 65.5 | 275.3 | 597.2 | 938.0 | 1,020 | 190 | 7.1 | 131 Nov 2008 | 807 | 643 | 48 | 1,497 | 44,921 | 22.5 | 65.4 | 279.0 | 560.4 | 904.8 | 1,029 | 192 | 7.1 | 138 Dec 2008 | 809 | 678 | 58 | 1,544 | 47,871 | 23.9 | 65.4 | 285.8 | 562.7 | 914.0 | 1,031 | 198 | 8.6 | 141 Jan 2009 | 864 | 659 | 44 | 1,567 | 48,567 | 24.3 | 66.8 | 276.4 | 586.0 | 929.3 | 1,078 | 199 | 6.2 | 141 Feb 2009 | 825 | 648 | 33 | 1,506 | 42,170 | 21.1 | 66.7 | 267.5 | 584.2 | 918.4 | 1,031 | 202 | 4.8 | 137 Mar 2009 | 865 | 720 | 36 | 1,621 | 50,242 | 25.1 | 67.6 | 258.9 | 606.0 | 932.4 | 1,067 | 232 | 4.9 | 145 Apr 2009 | 833 | 685 | 34 | 1,552 | 46,562 | 23.3 | 67.5 | 260.0 | 595.9 | 923.3 | 1,029 | 220 | 4.7 | 140 May 2009 | 823 | 655 | 35 | 1,514 | 46,920 | 23.5 | 66.6 | 256.8 | 598.6 | 922.0 | 1,031 | 213 | 4.9 | 137 Jun 2009 | 866 | 618 | 35 | 1,519 | 45,557 | 22.8 | 69.3 | 258.2 | 579.9 | 907.4 | 1,042 | 199 | 5.1 | 140 Jul 2009 | 833 | 674 | 40 | 1,547 | 47,953 | 24.0 | 68.6 | 282.6 | 572.2 | 923.4 | 1,012 | 199 | 5.8 | 140 Aug 2009 | 859 | 652 | 43 | 1,554 | 48,168 | 24.1 | 69.3 | 226.7 | 561.8 | 857.7 | 1,034 | 240 | 6.4 151 Sep 2009 | 938 | 671 | 48 | 1,657 | 49,708 | 24.9 | 71.2 | 5230.7 | 559.4 | 861.4 | 1,099 | 242 | 7.1 | 160 Oct 2009 | 847 | 622 | 44 | 1,513 | 46,914 | 23.5 | 74.9 | 238.1 | 562.2 | 875.2 | 944 | 218 | 6.6 | 144 Nov 2009 | 894 | 613 | 47 | 1,554 | 46,611 | 23.3 | 74.5 | 234.7 | 564.6 | 873.8 | 1,001 | 218 | 7.0 | 148 Dec 2009 | 891 | 635 | 49 | 1,575 | 48,839 | 24.4 | 73.3 | 248.1 | 582.4 | 903.8 | 1,015 | 213 | 7.1 | 145 Jan 2010 | 914 | 661 | 55 | 1,630 | 50,533 | 25.3 | 71.8 | 240.2 | 571.0 | 883.0 | 1,062 | 230 | 8.1 | 154 Feb 2010 | 853 | 675 | 53 | 1,581 | 44,270 | 22.1 | 75.3 | 246.6 | 573.5 | 895.3 | 945 | 228 | 7.8 | 147 Mar 2010 | 949 | 629 | 49 | 1,626 | 50,413 | 25.2 | 73.2 | 255.4 | 562.2 | 890.8 | 1,081 | 205 | 7.2 | 152 Apr 2010 | 926 | 637 | 50 | 1,614 | 48,408 | 24.2 | 73.2 | 244.1 | 540.8 | 858.1 | 1,055 | 218 | 7.7 | 157 May 2010 | 983 | 758 | 53 | 1,794 | 55,610 | 27.8 | 75.1 | 266.2 | 548.5 | 889.8 | 1,092 | 237 | 8.0 | 168 Jun 2010 | 942 | 733 | 53 | 1,728 | 51,846 | 25.9 | 73.8 | 267.3 | 527.4 | 868.5 | 1,064 | 229 | 8.4 | 166 Jul 2010 | 839 | 652 | 46 | 1,537 | 47,638 | 23.8 | 73.0 | 269.4 | 533.7 | 876.1 | 959 | 202 | 7.1 | 146

Nevada Environmental Response Trust Site Henderson, Nevada

TABLE 7: PERCHLORATE REMOVED FROM THE ENVIRONMENT

Nevada Environmental Response Trust Site Henderson, Nevada

Page 4 of 4 Ramboll Environ

TABLE 7: PERCHLORATE REMOVED FROM THE ENVIRONMENT

Nevada Environmental Response Trust Site Henderson, Nevada

These changes have not substantially impacted total perchlorate mass removal rates. Previously, data presented in Table 7 were based on calculations performed in the Envirogen/Veolia field spreadsheet. ENVIRON has not been able to locate perchlorate concentration and/or pumping data prior to July 2004, but has included the perchlorate removal numbers included in prior reports.

Notes:

-- = no data available gpm = gallons per minute lbs/day = pounds per day mg/L = milligrams per liter

Mass removal rates presented in this spreadsheet from months prior to January 2015 may be slightly different from previously reported mass removal rates for the following reasons:

1) Analytical data were obtained directly from the database for extraction wells and the GWTP east and west well feeds instead of the field spreadsheet.

2) Data interpolation and mass removal calculations were performed more systematically using a script developed in Matlab.

All values presented in Table 7 as of January 2015 were calculated by Tetra Tech.

Nevada Environmental Response Trust Site Henderson, Nevada TABLE 8: WEEKLY PERCHLORATE IN FBR INFLUENT AND EFFLUENT, JULY 2014 - JUNE 2015

Nevada Environmental Response Trust Site Henderson, Nevada TABLE 8: WEEKLY PERCHLORATE IN FBR INFLUENT AND EFFLUENT, JULY 2014 - JUNE 2015

Nevada Environmental Response Trust Site Henderson, Nevada TABLE 8: WEEKLY PERCHLORATE IN FBR INFLUENT AND EFFLUENT, JULY 2014 - JUNE 2015

Notes:

FBR = Fluidized Bed Reactor <u>es:</u> the gradient control of Reports (DMRs) associated with the Site's National Pollution Discharge Elimination System (NPDES) Permit

H = Sample prepped or analyzed beyond specified holding time

mg/L = milligrams per liter

SQL = Sample Quantitation Limit

TABLE 9: PERCHLORATE PLUME MASS ESTIMATES

Nevada Environmental Response Trust Site Henderson, Nevada

Notes:

Mass values are presented in tons.

AWF = Athens Road Well Field

UMCf = Upper Muddy Creek Formation

Mass estimations for 2014 and 2015 are presented with a 95% margin of error, which was calculated from the standard deviation of the interpolated concentrations and aquifer thicknesses.

TABLE 10: CHROMIUM PLUME MASS ESTIMATES

Nevada Environmental Response Trust Site Henderson, Nevada

Notes:

Mass values are presented in tons.

AWF = Athens Road Well Field

UMCf = Upper Muddy Creek Formation

Mass estimations for 2014 and 2015 are presented with a 95% margin of error, which was calculated from the standard deviation of the interpolated concentrations and aquifer thicknesses.

TABLE 11: AVERAGE PERCHLORATE MASS LOADING IN LAS VEGAS WASH

Nevada Environmental Response Trust Site Henderson, Nevada

Reporting Year LV Wasteway Pabco Road Northshore Road Upstream of Wasteway Las Vegas Wasteway to Pabco Road $2007/2008^1$ 1.96 23.34 68.73 3% 3% 31% 66% 2008/2009 2 | 1.69 | 16.71 | 70.60 | 2% | 21% | 76% 2009/2010 | 1.60 | 30.21 | 62.05 | 3% | 46% | 51% 2010/2011 1.49 18.74 71.05 2% 24% 74% 2011/2012 | 1.26 | 9.69 | 76.35 | 2% | 11% | 87% 2012/2013 1.44 27.94 68.57 2% 39% 59% 2013/2014 1.77 | 30.00 | 67.26 | 3% | 42% | 55% 2014/2015 1.38 20.08 64.56 2% 29% 69% **Average 1.57 22.09 68.65 2% 30% 68% Average Perchlorate Mass Loading (lbs/d) Percentage Loading at Northshore Road from**

Notes:

lbs/d = pounds per day

Reporting year is July through June

 1 2007 third quarter mass loading estimate missing.

 2 2009 first quarter mass loading estimate missing.

Pabco Road to Northshore Road

TABLE 12: GW-11 WATER ELEVATION, WATER VOLUME, AND FLOW

Nevada Environmental Response Trust Site Henderson, Nevada

TABLE 12: GW-11 WATER ELEVATION, WATER VOLUME, AND FLOW

Nevada Environmental Response Trust Site Henderson, Nevada

Notes:

Influent and effluent flow rates were calculated in the GWETS field spreadsheet maintained by Tetra Tech.

A new GW-11 influent flow meter was installed on April 27 to track GW-11 total influent flow. Prior to this date, influent flows were estimated using the sum of flows from Lift Station 2 and the GWTP.

*Evaporation has a significant impact on pond volume. Using historic pan evaporation data, ENVIRON calculated approximate evaporation rates for GW-11 in gpm (Shevenell, 1996).

GW-11 did not operate as an equalization basin between August 6, 2014 and January 7, 2015.

 $gpm = galtons per minute$ ft amsl = feet above mean sea level

Mgal = millions of gallons

Source: Shevenell, Lisa. 1996. Nevada Bureau of Mines and Geology, Report 48: Statewide Potential Evapotranspiration Maps for Nevada.

TABLE 13: GW-11 ANALYTICAL MONITORING

Nevada Environmental Response Trust Site

Henderson, Nevada

Notes:

Although requested by NDEP, ammonia was not analyzed in the initial GW-11 sample.

pH was not specified in NDEP's original GW-11 monitoring request, but was added for consistency with the groundwater monitoring program during the July 25, 2014 GW-11 sampling event.

mg/L = milligrams per liter

µg/L = micrograms per liter

NA = not analyzed

TDS = total dissolved solids

TSS = total suspended solids

SU = standard unit

Samples listed as composite were collected from GW-11 as four-point composite samples. Samples listed as effluent were collected from the GW-11 effluent pipe.

GW-11 effluent was not analyzed for chloride, sulfate, ammonia, phosphorus, calcium, iron, TDS, TSS, and pH during May, June, August, October, November, and December 2014.

GW-11 did not operate as an equalization basin between August 6, 2014 and January 7, 2015.

TABLE 14: GW-11 PERCHLORATE MASS ESTIMATE, JULY 2014 - JUNE 2015

Nevada Environmental Response Trust Site Henderson, Nevada

Notes:

GW-11 began functioning as an equalization basin on March 27, 2014. GW-11 did not operate as an equalization basin between August 6, 2014 and January 7, 2015.

 $-$ = no value

lbs = pounds

 $Mgal =$ million gallons

mg/L = milligrams per liter

TABLE 15: GWETS PERFORMANCE METRICS SUMMARY

Nevada Environmental Response Trust Site

Henderson, Nevada

TABLE 15: GWETS PERFORMANCE METRICS SUMMARY

Nevada Environmental Response Trust Site

Henderson, Nevada

Notes:

 1 Average mass removal rate at each well field between July 2014 and June 2015. Monthly removal rates are shown on Table 7.

² Average mass removal rate at the Groundwater Treatment Plant (GWTP) and Fluidized Bed Reactor (FBR) between July 2014 and June 2015. Monthly removal rates at the GTWP are shown on Table 5.

³ The average mass removal rate is calculated using influent and effluent hexavalent chromium concentration data at the GWTP and average monthly flow to the GWTP. This calculation is performed by Tetra Tech as of January 2015.

⁴ The average mass removal rate is calculated using influent and effluent total chromium concentration data at the FBRs and average monthly FBR flow data.

Annual Remedial Performance Report For Chromium and Perchlorate Nevada Environmental Response Trust Site Henderson, Nevada

FIGURES

Path: H:\LePetomane\NERT\GWM\Annual Performance Reports\2015 Annual\GIS\Fig 31a-Shallow Capture Zones.mxd

Path: H:\LePetomane\NERT\GWM\Annual Performance Reports\2015 Annual\GIS\Fig 31b-Middle Capture Zones.mxd

Path: H:\LePetomane\NERT\GWM\Annual Performance Reports\2015 Annual\GIS\Fig 31c-Deep Capture Zones.mxd

-
-
-
-
- -
	-

Sampling Locations in L a s Ve g a s Wa s h

Nevada Environmental Response Trust Site Henderson, Nevada

Path: H:\LePetomane\NERT\GWM\Annual Performance Reports\2015 Annual\Figures\Fig 33a-Las Vegas wash Sampling Location.mxd

L e g e n d

La USGS Stream Gauge Station NERT/AMPAC/TIMET Outfall Location Model Boundary Site Boundary Downgradient Plume

Miles

RAMBULL ENVIRON

Annual Remedial Performance Report For Chromium and Perchlorate Nevada Environmental Response Trust Site Henderson, Nevada

PLATES

-
-
-

-
-
-
-
-

 $1750.0'$ TOB OF CARING ELEVATION MELLE UDADANENT AE BADDIED MALL.

 $1480 -$

Path: H:\LePetomane\NERT\GWM\Annual Performance Reports\2015 Annual\Plates\2015Q2 - P08 - TDS.mxd

- TDS

JD

Annual Remedial Performance Report for Chromium and Perchlorate Nevada Environmental Response Trust Site Henderson, Nevada

> **APPENDIX A GROUNDWATER ELEVATIONS AND ANALYTICAL DATA**

Notes:

 $FD = field$ duplicate

ft amsl = feet above mean sea level

J = Concentration is estimated

J- = Estimated concentration, potential negative bias

J+ = Estimated concentration, potential positive bias

mg/L = milligrams per liter

< = Concentration is less than indicated laboratory method reporting limit

UJ = Concentration is estimated and less than indicated laboratory method reporting limit

Nevada Environmental Response Trust Site Henderson, Nevada

Nevada Environmental Response Trust Site Henderson, Nevada

Nevada Environmental Response Trust Site Henderson, Nevada

Notes:

Data in this table have been provided by others. Ramboll Environ and the Trust have not independently verified these data.

mg/L = milligrams per liter

µg/L = micrograms per liter

AMPAC = American Pacific Corporation

Nevada Environmental Response Trust Site

Henderson, Nevada

OSSM = Olin Chlor-Alkali/Stauffer/Syngenta/Montrose

SNWA = Southern Nevada Water Authority

TIMET = Titanium Metals Corporation

NA = Not analyzed

NR = Not recorded

NM = Not measured

-- = Result is available from the NERT site sampling and is presented in Table A-1

mg/L = milligrams per liter

ft amsl = feet above mean sea level

< = Concentration is less than indicated laboratory method reporting limit

J = Concentration is estimated

J- = Estimated concentration, potential negative bias

 $J+$ = Estimated concentration, potential positive bias

¹ AMPAC's TDS results were converted from field specific conductivity measurements using a conversion factor of 0.707.

 2 Specific Conductivity was analzed, but results were beyond the field instrument's range.

Annual Remedial Performance Report for Chromium and Perchlorate Nevada Environmental Response Trust Site Henderson, Nevada

> **APPENDIX B WELL DATA SHEETS**

Annual Remedial Performance Report for Chromium and Perchlorate Nevada Environmental Response Trust Site Henderson, Nevada

Well Data Sheets

Data summary sheets for individual extraction and monitoring wells are provided in Appendix B. The data sheets show key well performance indicators for all wells, including water levels, perchlorate concentrations and chromium concentrations over the period 1999-2015. Additional key well performance indicators are shown for the extraction wells, including flow rates, specific capacity, mass removal rates, and the average perchlorate and chromium concentrations for the second quarter of 2015. For each extraction well field, the concentration plots for each analyte have identical ranges unless otherwise specified to facilitate comparison wells within a single well field. In addition, the data sheets show well construction details (top of casing, screened interval, Qal/UMCf contact, and the total well depth) for comparison to the groundwater elevations. The well construction details were compiled from the all wells database spreadsheet maintained by NDEP. Construction details for several wells are not plotted due to a lack of key data in the all wells database. All other data shown in the data sheets were from the site database.

Perchlorate and chromium concentration trends, calculated as a monthly average of the data and interpolating where no data were available in a given month, are shown as solid lines. Individual laboratory analytical results are shown with a solid symbol for detected values and an open symbol for non-detected values. Pumping rates are shown as monthly averages from July 2002 through June 2015, compiled into the site database from the operational field spreadsheets. Mass removal rates for perchlorate and chromium were calculated by multiplying the monthly average pumping rate by the monthly average concentration. For the purposes of the mass removal calculations, the monthly average concentration was assumed to be zero for non-detected results. The specific capacity is calculated using the methodology outlined in Appendix B of the 2013 GWETS Optimization Project Report (Attachment A of ENVIRON 2015).

ENVIRON. 2015. Semi-Annual Performance Report for Chromium and Perchlorate, July – December 2014. April 30.

Annual Remedial Performance Report for Chromium and Perchlorate Nevada Environmental Response Trust Site Henderson, Nevada

> **APPENDIX C GROUNDWATER FIELD RECORDS**

ifirst Querter VV — II IVI ordit ortineg

Je a value in the start of the s <u>s and the second second</u> ileralerano a p

February 2, 2015 thru March 3, 2015

CONTENTS

Field Data Letter Report

Section

Letter of Transmittal

Andrew Harley Date: March 31, 2015 Attention: Principal Geochemist Tetra Tech 350 Indiana Street, Suite 500 Golden, CO 80401

Project:

2015 1st Quarter Groundwater Monitoring

Enclosed:

1 copy of Field Data Letter Report

Remarks:

Andrew,

The enclosed Quarterly Groundwater Monitoring Report with supporting documents is provided for your records.

Signature: Wendy Bescott

Wendy Prescott

Envirogen Technologies Two Kingwood Place 700 Rockmead Drive Suite 105 Kingwood, TX 77339

Field Data Letter Report

INTRODUCTION \mathbf{I}

Nevada Environmental Response Trust (NERT) contracts with Envirogen Technologies to conduct groundwater sampling and analysis at their Perchlorate Removal Facility, located at 510 Fourth Street, in Henderson, Nevada. The work described herein represents the first quarter groundwater sampling event for 2015. The work was conducted in accordance with the Envirogen O&M Contract signed on December 5, 2012.

Envirogen has three staff members trained to assist the quarterly well monitoring events. The Envirogen monitoring team meets once prior to the sampling event to discuss all issues associated with this project, sampling and laboratory equipment needs, time tables and well site schedules. Bottle orders and bottles received are cross checked to ensure that all wells and analysis are represented.

1.1 **SCOPE OF SAMPLING EVENT**

This sampling effort included the following tasks:

- Soundings of the pumping water levels in 27 interceptor wells. \bullet
- Soundings of the water levels in 3 dormant interceptor wells \bullet
- Collection of groundwater samples from 30 interceptor wells.
- Soundings of water levels in 105 monitoring wells.
- Collection of groundwater samples from 82 monitoring wells.
- Collection of groundwater samples from 17 pumping wells.
- Collection of water levels in 5 backup (Buddy) wells.

Collection of groundwater samples from 2 dormant ART wells (ART-6 and ART-7A).

Analysis of samples collected from the interceptor and monitoring wells, range from Perchlorate (CLO4), Total Chromium (Cr), Hexavalent Chromium (CRVI), pH, Specific Conductance (EC), Total Dissolved Solids (TDS), and NPDES list for well M-10, (Up Well). CR, MN, FE, B, Ammonia, TIN, Nitrate-Nitrite as N, and Chloide.

Groundwater samples were shipped daily to TestAmerica (TA) for analysis, in Irvine, California. TA is certified by the State of Nevada.

The scope of this assignment also included compiling the water level and analytical data presented in this report. Data are presented in tabular form.

$\overline{2}$ **FIELD ACTIVITIES**

Envirogen conducted the field activities associated with this quarterly sampling event between Monday February $2nd$ and Tuesday March 3, 2015. Activities included the sounding of "pumping" water" levels in the interceptor wells, sounding the "static water" level in the monitoring wells and sampling of both the interceptor and monitoring wells. Prior to each quarter, an inventory list was issued to Environ for review and comment. Sampling was conducted according to their specifications.

Jeff Lambeth, Wendy Prescott, Tobin Walker and Michele Brown were responsible for sample collection and recording all pertinent data on sample bottles. Michele Brown supervised the groundwater sampling activities. She is responsible for executing all work elements related to the groundwater sampling program, including laboratory equipment maintenances and calibration, fieldwork, documenting field activities, maintaining field notes and photographs (when applicable), and providing the Operations Manager with information concerning implementation of the sampling plan.

Envirogen maintained records of daily events and pertinent sampling data of each well on a field log sheet and addendum data in a bound log book. Log sheet entries included personnel onsite, weather conditions, water levels, activities conducted, sampling times, pH, EC, temperature and other significant field information.

2.1 Groundwater Level Soundings

Envirogen sounded pumping water levels in 27 interceptor wells. The static water readings were taken in Interceptor wells I-AB, I-AC and I-AD. In addition to the interceptor wells, static water levels in 105 monitoring wells were taken. There were twenty-eight (28) wells where only static water levels were taken. The following are the 28 wells:

The water levels were sounded to the nearest 0.01 foot using an electronic well sounder.

2.2 **Equipment Cleaning Procedures**

The Deionized water is changed each morning so the rinsing water is fresh. Non Dedicated sampling equipment has been replaced with dedicated tubing or use of disposable bailers where necessary.

The conductivity/pH probe was rinsed thoroughly with DI water after every sample was analyzed.

Following the sounding of water levels at each well the static probe was rinsed by spraying first with soapy water and then rinsed with DI water.

Following the sampling of each well the equipment was washed and purged using DI water containing Liquinox soap then rinsed and purged using clear DI water. The rinse water was collected in a polyethylene container and transported to GW-11 for treatment.

3.0 **GROUNDWATER SAMPLING**

3.1 **Sampling Locations**

The following presents the identification of wells sampled.

3.1.1 Interceptor Wells

$3.1.2$ Pumping Wells

$3.1.3$ **Monitoring Wells**

SAMPLING TECHNIQUES 4.0

4.1 Interceptor Wells

All interceptor wells were sampled using dedicated sampling ports. At the beginning of sampling each well or line, personnel wore a new pair of clean nitrile or latex gloves. The sampling port was opened to drain any stagnant water from piping and valves. This water is captured and containerized. All captured water is off-loaded at GW-11 for onsite treatment.

Following the purging of the sample port, a "water quality" sample was collected for analysis of Perchlorate, Total Chromium, pH, and TDS. Envirogen also recorded the "field" temperature, pH, and conductivity as well as the pumping water level. The "field" parameters are provided in Table 1.

4.2 Monitoring Wells

Monitoring wells were purged before sampling to assure that each sample was collected from fresh formation water. Eighty (80) wells were purged and sampled, using the 12 volt submersible pump. Three (3) wells, M-99, ART-7A and ART-6 were sampled with a disposable bailer. One (1) well M-38 was sampled with a dedicated bailer. M-99 was not purged due to location and/or water column level but samples were collected. Hand bailing was done as a result of only needing to purge less than 3 gallons of water, if there was an insufficient amount of water in the well casing to use a pump or due to the location of the well.

Samples for both the interceptor and monitoring wells were collected in appropriate containers supplied by TestAmerica and analyzed for the specific required analysis of the well. The bottles were filled with minimal aeration, using laminar flow.

The samples were labeled, packaged, stored, and transported using the procedures outlined in the work plan for well samples.

4.3 Problems Encountered

Cast Lids are missing from PC-94 and PC-90. Wells are capped and locked and large rocks were placed over the casing for protection.

Submersible pump quit working at $M-48A$ on 2-24-15. Changed out to new pump. On 2-25-15 the sampling trailer was revamped with new fittings to achieve quicker and easier

sampling techniques for the sampling team.

5.0 **QUALITY CONTROL**

Quality control (QC) procedures include collection and analysis of QC duplicate samples, equipment and field blanks. The analytical laboratory is also required to meet specific QA/QC requirements for surrogate recovery, MS/MSD recovery and RPDs, and LCS recoveries. Duplicate EC readings were conducted at one well cach day to insure the accuracy of the Hanna field probe.

5.1 **OC** Duplicate Samples

QC duplicate samples were collected during the sampling event to evaluate the precision and accuracy of analytical data. The QC duplicates were collected, packaged, and transported in the same manner as the primary sample, but assigned a different identification number. Four (4) duplicates were collected from the wells, representing at least 5 percent of the samples collected. The duplicate samples were collected from the following wells M-44, M-68, M-37 and M-81A. They were analyzed for the same parameters as the primary samples. TestAmerica was not informed of the identity of these "blind" samples.

5.2 **Equipment Blanks**

Three equipment blanks were taken this quarter. The equipment blanks were collected on, February 13, 25 and 26, 2015. One set of three (3) bottles, CLO4, pH, TDS, CR and CRVI) for two days and one (1) bottle, CLO4, for the Monthly/Quarterly sampling for a total of seven (7) bottles. This was done to evaluate the adequacy of cleaning procedures used by field personnel during this sampling event.

5.3 Field Blanks

One field blank sample was collected on February 24, 2015. One set of three bottles were sent to the laboratory for analysis to evaluate the integrity of the de-ionized water used to clean and purge the sampling equipment.

$6.0\,$ ANALYTICAL PROCEDURES

The following designates the parameter, analytical method and method reporting limits for groundwater. Some of the following analysis may not have been performed for this reporting period.

6.1 Field Equipment Calibration

Prior to the start of each day's events, field laboratory equipment was calibrated. A Hanna HI 98130 water proof pH, EC/TDS and temperature field probe was calibrated and measurements recorded on daily laboratory calibration maintenance forms, which have been provided. Each day a duplicate EC reading was taken at random wells to ensure the calibration of the meter was holding. The duplicate EC readings were taken from wells ARP-5A, M-38, M-69, M-80, PC-55, PC-68, PC-73 and PC-98R.

SUMMARY RESULTS

7.1 Groundwater Level Soundings

A summary of water level soundings collected for the interceptor and monitoring wells are presented in Table 1.

Pumping water level in interceptors wells. (Measured in feet from below the top of casing.)

LOW

44.71 $(I-AA)$

HIGH

 24.24 $(l-1)$

Static water level monitoring wells. (Measured in feet from below the top of casing.)

LOW **HIGH** 69.45 (M-10) 4.63 (PC-97)

- 7.2 Summary of Field Activities
- $7,2,1$ Interceptor Wells CLO4, Cr, TDS, pH thirty (30) interceptor wells

$7,2,2$ Monitoring Wells

Eighty- three (83) Monitoring wells sampled for sets that may have included: pH, TDS, CLO4, CR, and CRVI

7.2.3 QC Duplicate Samples (Measured for the same analyses as the primary samples.)

M-44, M-37 (Measured for pH, CR, CRVI, CLO4, TDS)

M-81, M-68 (Measured for Total Cr., pH, CLO4 and TDS)

Equipment Blanks $7.2.4$

Two (2) equipment blanks were analyzed for CLO4, Total Cr., Hex Cr., pH, and TDS. One (1) equipment blank was analyzed for CLO4 only.

7.2.5 Field Blank

One (1) field blank was analyzed for CLO4, Total Cr., Hex Cr., pH and TDS.

 \cdot

ENVIROGEN QUARTERLY SAMPLING SIGN IN SHEET

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: $2 - 2 - 15$

HANNA FIELD pH METER

HANNA FIELD EC METER

All equipment was rinsed and purged with Deionized water after each use.

 $\ddot{}$

 $\sim 10^{-11}$

÷,

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: 2-10-15

HANNA FIELD pH METER

HANNA FIELD EC METER

 $\sim 10^{-11}$

 \mathcal{A}

 $\bar{1}$

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: $2-11-15$

HANNA FIELD pH METER

HANNA FIELD EC METER

All equipment was rinsed and purged with Deionized wate
Date $Q-1$ -15 Verified -100 ter after each use.

 $\overline{}$

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: $2 - 12 - 15$

HANNA FIELD pH METER

HANNA FIELD EC METER

 $\sim 10^{-10}$

 $\sim 10^{-11}$

 $\sim 10^{11}$ km $^{-1}$

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: $2-13-15$

 $\mathcal{A}^{\text{max}}_{\text{max}}$

 $\sim 10^{11}$ km

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: 2.18-15

 $\label{eq:2.1} \frac{d\mathbf{y}}{dt} = \frac{1}{2} \left(\frac{d\mathbf{y}}{dt} - \frac{d\mathbf{y}}{dt} \right)$

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: 2-23-15

 $\ddot{}$

 $\sim 10^{-1}$

 ~ 10

ï

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: 2-24-15

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: 2-25-15

HANNA FIELD pH METER

HANNA FIELD EC METER

Well # $M = M$

2nd Reading

1st Reading

 $rac{5.20}{m5km}$ Temp. $rac{25.6}{m5}$

EC 5.20 Temp 25.4 pc

All equipment was rinsed and purged with Deionized water after each use.

Date $2.35.15$ Verified $M0$

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: $2-d6.15$

HANNA FIELD pH METER

HANNA FIELD EC METER

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: $2-27-15$

HANNA FIELD pH METER

HANNA FIELD EC METER

DAILY MAINTENANCE AND CALIBRATION RECORD

DATE: $3.3 - 15$

HANNA FIELD pH METER

HANNA FIELD EC METER

 $Date \overline{3.3.15}$ verified $M\overline{B}$ No Dup EC Today only one well sampled

Summary of Field Data for: 1st Quarter Groundwater Monitoring, February 2015 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada TABLE 1

COMMENTS/Analytical Plan/Temp pH, TDS, Cr, ClO. pH, TDS, Cr, CIO, pH, TDS, Cr, CIO, pH, TDS, Cr, CRO, pH, TDS, Cr, CIO, pH, TDS, Cr, ClO, pH, TDS, Cr, ClO₄ pH, TDS, Cr, ClO, pH, TDS, Cr, CIO, rH TDS Cr CIO. pH, TDS, Cr, CIO, pH, TDS, Cr, CIO, oH TDS, Cr, CIO, DTW Only DEW Only DTWO_{bly} DTW Only DTW Only DTW Only MONITORING
QUALIFIER² well capped TIME $11:19$ 1110 tar $1\bar{1}\bar{3}$ 12.09 $11:8$ Ξ $11:05$ 11:06 $11:37$ 1133 1132 12:30 $11:22$ Ξ $\frac{2}{12}$ $95\,$ $\tilde{\mathbb{S}}$ 2122015 23.2015 23/2015 23:2015 20.2015 23:2015 23:2015 2/13/2015 2/12/2015 2/12/2055 212:2035 23/2035 2/11/2015 25:2015 23:2015 23:2015 23/2015 23/2015 **DATE** $\begin{bmatrix} \text{SPECEFC} \\ \text{CNDICTNITY} \\ \text{(nSem)} \end{bmatrix}$ $12.02\,$ 10.09 7.82 \$.09 $\tilde{\mathbf{g}}$ ŠΩ 9.91 7.15 7.39 γ sg 786 7.54 23 \overline{r} s 7.46 737 7.67 733 747 핑 $\frac{1}{2}$ 2 GROUNDWATER
ELEVATION
(FT NSL) 1590.05 1586.45 1582.58 1588.70 1584.71 1584.60 1589.32 1590.46 1588.73 1587.00 $15/9.23$ 1579,03 1588.69 1587.08 161537 1589.40 1586,94 1584.11 1587.71 $\begin{array}{|c|c|}\n\hline\n\text{AQUEOUS} \\
\hline\n\text{HMS} \\
\hline\n\end{array}$ $LICUD^{-1}$ DEPTH_{TO} WATER (FER) 37.04 25.48 30.96 29.09 $27.05\,$ 28.03 30.93 $36%$ 28.3° 26.96 $28.53\,$ 51.39 25.15 2.94 38.37 28.77 28.11 23.92 $\begin{array}{c} \hline \text{rope} \\ \text{Casso} \\ \text{EENING} \end{array}$ 1614.18 1613.47 1616.10 1614.40 1617.39 1614.78 1613.32 1683.20 1617.10 1617.93 1617,60 1617.46 1615.19 1614.67 1615.56 16147 1616.89 1615.37 1619.62 (MSL) from TOC TOTAL
DEFTH 38.9 39.2 $\frac{1}{4}$ \mathfrak{S} \ominus S, \mathcal{D} \mathcal{P} $\mathrel{\mathop:}$ S. 녹, Sć $\frac{5}{2}$ Ş Š, 46 ¥ र्ज़ \mp WELL# 1317.78 $\frac{1}{2}$ 18244 **ARP-6B** AR1-14 ART-3A $481 - 44$ ARP 34 ARP-54 18124 1RP-24 $ARI-3$ 1814 $\frac{1}{2}$ 1807 ARP 7 ART-1 IPT₂ \overline{R}

Summary of Field Data for: 1st Quarter Groundwater Monitoring, February 2015 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada TABLE₁

Summary of Field Data for: 1st Quarter Groundwater Monitoring, February 2015 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada **TABLE 1**

COMMENTSAnalytical Plan/Temp pH / TDS / Cr / Cr6 / CI04 H. G. Cr / ClO. / TDS pH : Cr : Cr⁶ : ClO . / TDS pH/O/0⁶/00.7TDS pH TDS Cr CIO. BH TDS, Cr, CIO, pH, TDS, Cr, CIO, pH, TDS, Cr, CIO, pH, TDS, Cr, ClO, the most cross pH, TDS, Cr, CIO, pH, TDS, Cr, CIO, pH, TDS, Cr, ClO, pH, TDS, Cr, ClO, DTW Only DTW Only DTW Only **DEW Only** MONITORING
QUALIFIER² destroyed TIME $\frac{4}{101}$ $12.30\,$ 10:49 $10\mu\mathrm{s}$ $\hat{\mathbb{S}}$ $10,10$ $\frac{8}{26}$ 1120 10:46 $10:23$ $\mathop{\mathbb{S}}\limits^{\mathfrak{A}}$ $\frac{1}{2}$ 929 $\mathcal{S}^{\infty}_{\mathcal{A}}$ 928 $\frac{4}{34}$ $\ddot{\Sigma}$ 2/27/2015 2/16/2015 2252015 225/2015 226/2015 2/26/2015 226/2015 2272015 227:2015 224.2015 2/24/2015 226:3015 216:2015 216/2015 225/2015 2/16/2015 2/25/2015 **DATE** $\begin{array}{|l|} \hline \texttt{SPECTRIT} \\\hline \texttt{CoSECTNITY} \\\texttt{(mSim)} \\\hline \end{array}$ Sampled in the 2nd Quarter only 13.46 14.33 $\frac{15}{10}$ 10.95 6.71 7.16 5.63 \mathfrak{S} 6,5 $\tilde{\cdot}$ 3.61 55 \$25 7.85 7.18 $\boldsymbol{2.09}$ 5.88 \mathbb{S} 7.02 7.47 7.33 $7.20\,$ 7.67 \overline{z} 퓔 GROUNDWATER
ELEVATION
(FT NSL) 1729.18 1673.25 1687.86 1759.66 1721.36 1720.78 1723.98 124.19 1800.29 1739.86 1759.82 1728.57 1719.04 1723.57 1721.02 1718.40 1721.26 1722.71 ESSTEL
SCORE STATE LIO and \sim DEPTH TO (FET) 31.88 25.06 30.50 42.06 31.79 28.50 $13.13\,$ 26.C4 32.92 31.36 29.52 29.87 30.23 32.54 31.53 21.93 TOP OF 1772.78 1759.82 1761.06 1759.73 1718.36 1801.92 1750.88 1750.83 1751.44 1751.25 1749.76 1750.23 1800.29 1750.94 1753.91 1754.24 1745,91 1698.31 (351) **Erom IOC** TOTAL
DEPTH 56.78 ± 3.00 39.70 $77.85\,$ 37.18 37.65 47.38 45.00 40.00 42.40 45.00 38.00 ±0.00 $43.00\,$ 38.00 41.00 35.32 Ş WELL# 84-57.4 $11-48.1$ $\frac{3}{2}$ $M-68$ $\frac{4}{2}$ $M-S5$ $\frac{3}{2}$ W_M $51₆$ $+66$ \sim $M-33$ 436 $\frac{6}{2}$ $1 - 38$ $\frac{1}{2}$ VI 56 $1-35$

Summary of Field Data for: 1st Quarter Groundwater Monitoring, February 2015 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada **TABLE 1**

COMMENTS/Analytical Plan/Temp pB/TDS/Cr/Cr6/Cl04 pH/Cr/Cr⁶/ClO₄/IDS pH : Cr : Cr³ : CIO, : TDS M/TDS/Cr/CIO. pH, TDS, Cr, CIO, aH, TDS, Cr, CIO₄ pH, TDS, Cr, CIO, IM, TDS, Cr, CIO, pH, TDS, Cr, ClO. pH, TDS, Cr, CIO, pH, TDS, Cr, CO₃ (DS/ Cr/ ClO **DTWONLY DTWONLY DTWONLY** DTW ONLY DTW ONLY **DTWONDY** MONTIORING
QUALIFIER² Ë \mathbb{H} $12.15\,$ $\frac{30}{2}$ **State** i026 1120 13:56 13:12 13:26 13:39 $10:25$ $10\, \mathrm{M}$ $0.53\,$ 10:06 $12:53$ 11.47 \$36 8:02 952 225/2015 2/13/2015 216/2015 2:24:2015 226/2015 216:2015 2/16/2015 216:3015 216/2015 2/25/2015 2/26/2015 226:2015 216/2015 224:2015 225/2015 2/25/2015 2252015 2/26/2015 **BATE** $\begin{array}{|c|c|}\n\hline\n\multicolumn{1}{r}{\text{SPECTFET}} \\
\hline\n\multicolumn{1}{r}{\text{CONUCITFITY}} \\
\hline\n\multicolumn{1}{r}{\text{(mS/cm)}}\n\hline\n\end{array}$ $11,55$ $\frac{1}{2}$ 5.08 \tilde{c} $\tilde{\mathbf{S}}$ S 8.96 7.34 Ş $\frac{3}{5}$ 7.81 7.48 594 $\mathfrak{D}% _{T}=\mathfrak{D}_{T}\!\left(a,b\right) ,\mathfrak{D}_{T}=\mathfrak{D}_{T}\!\left(a,b\right) ,$ 7.69 710 Ξ 724 7.27 $\overline{\mathbf{g}}$. $\overline{\mathbf{g}}$ LS p 핖 **GROUNDWATER**
ELEVATION
(FT MSL) 1711.10 1708.45 $\frac{3}{2}$ 1764.70 1676.16 1716.00 1716.80 1742.79 1759.40 1719.12 1709.84 1762.29 1693.52 1710.47 1744.00 1713.07 1714.41 1712.82 **DEPTHTO** (EET) $\hat{\omega}$ 55.18 56% 32.03 28.32 27.58 42.43 2.38 31.43 36.20 31.47 36,05 35.25 17,93 $35\,71$ $\frac{1}{2}$ $rac{21}{40}$ $\begin{array}{|c|c|}\n\hline\n\text{CASSIC} & \text{SING} \\
\hline\n\text{ELEVATION} & \text{SUSC}\n\end{array}$ 1749.75 1741.14 1741.16 1742.77 1800.76 1694.09 1693.52 (748.25) 1785.22 1751.50 1742.53 1746.04 1797.54 TOP OF 1747.04 1746.49 1741.38 1799.61 (MST) 1784.21 from TOC) TOTAL
DEFTH \$5.00 53.90 $\frac{50}{7}$ 920 37.60 43.70 41.69 42.80 48.50 49.00 30.00 16.90 40.00 ±1.00 39.00 $\, 43.60$ 43.00 36.00 WELL # M-81.4 $\frac{32}{2}$ $\frac{8}{2}$ **M-80** 3.93 $36h$ $\frac{1}{x}$ $\frac{1}{2}$ $\frac{6}{3}$ $\mu_{\rm H}$ 1.78 ~ 1 192 $1-69$ -10 $M/3$ $\frac{12}{3}$ $\overline{1}$
Summary of Field Data for: 1st Quarter Groundwater Monitoring, February 2015 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada TABLE 1

COMMENTS/Analytical Plan/Temp NUTDS/Cr/Cr6/CR4 pH, TDS, Cr, CIO, pH, TDS, Cr, CIO₄ pH, TDS, Cr, CIO_s pH, TDS, Cr, CIO, pH, TDS, Cr, CIO₃ **DTWONLY DTWONLY** DTW Caly DTW Only DTW Only DTW Orly DTY Only DTW Only DTW Only DTW Only DTW Only DTW Only MONITORING
QUALIFIER² $\bar{\varepsilon}$ Ä έ $\overline{\rm LML}$ 1108 $1195\,$ $11.03\,$ $10:39$ 10:00 10:02 98 $10;07$ $10:12$ Ě $r_{\rm 33}$ 10:28 959 \sim 6.36 $\tilde{\mathbf{x}}^0$ 957 82! 227/2015 216:2015 2002015 237/2015 2/17/2015 2222015 216.20I5 216:2015 2/16/2015 2242015 226/2015 216:2015 216/2015 216(2015) 216:2015 216:2015 216/2015 2/16/2015 DATE $\begin{array}{c|c}\n\hline\n\text{SPECEHC} \\
\hline\n\text{CNDICTFUTY} \\
\text{(mSem)}\n\end{array}$ ± 8 $^{4.50}$ $\frac{5}{4}$ $\frac{1}{2}$ 7.66 7.67 필 GROUNDWATER
ELEVATION
(FT MSL) 1721.45 1749.66 1717.13 1720.52 1721.72 1721.33 1717.14 1721.33 1721.26 1721.80 1721.41 1760,94 1731.90 1697.01 1730.93 1730.81 1728.54 $[722.27]$ $\begin{tabular}{|c|c|} \hline \text{non.} \\ \hline \text{AQUBOS} \\ \hline \text{PHSSE} \\ \hline \end{tabular}$ DEPTHTO (EET) 33.70 39.76 28.69 26.I9 33.45 29.36 $21.33\,$ 24.02 37.98 3.59 28.42 20.57 34.71 29.21 39.91 $\begin{array}{|c|c|}\n\hline\n\text{top or} & \text{in} \\
\hline\n\text{CASSING} & \text{in} \\
\hline\n\text{FIEYATION} & \text{in} \\
\hline\n\end{array}$ 1750.66 1742.74 $1/45.35$ 1800.85 1730.74 $1/51.85$ \$751.09 1750.58 1749.88 1731.90 1787.64 1748,46 1750.22 1742.29 1730,93 1749.95 (MSL) 1730.81 1754.13 $(1001 100)$ **TOTAL**
DEPTH 32.15 35.00 37.00 28.00 29.00 50.00 $33.40\,$ 47.50 $32.00\,$ 35.00 40.00 52.50 39.00 59,00 30.00 35,00 35.59 $\frac{33}{21}$ WELL# M-176 $M-1/3$ NH75 91-100 $101 - 10$ $M - 115$ 1131 $M-135$ 31-166 M-167 $M-163$ M-169 **M-170** 117 $M - 174$ **SG-PK 1.99** 1.97

Summary of Field Data for: Ist Quarter Groundwater Monitoring, February 2015 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada TABLE 1

COMMENTS Analytical Plan/Temp pH, TDS, Cr, CIO. pH, TDS, Cr, ClO₃ pH, TDS, Cr, ClO, pH, TDS, Cr, ClO, pH, TBS, Cr, CIO, pH, TDS, Cr, ClO₄ pH, TDS, Cr, ClO, pH, TDS, Cr, ClO, pH, TDS, Cr, CIO, DTW Only MONITORING
QUALIFIER ² P & A TIME 10:56 1244 $\mathbb{C}\mathbb{C}^n$ $10:30$ 1125 $1105\,$ 12.3 $12:00$ 10:58 1130 10:07 $\overline{122}$ $\bar{\rm s}$ $\mathbb{Q}6$ \$15 $\overline{}$ 2/1/2015 2/10/2015 2/10/2015 2/10/2015 2/1/2015 2/11/2015 2/1/2015 2/11/2015 2122015 211/2015 217/2015 282/2015 2/13/2015 2022015 2/13/2015 2/10/2015 **DATE** $\begin{array}{|l|} \hline \texttt{SPECTNITY} \\ \hline \texttt{CONDCTIONITY} \\ \hline \texttt{(mStem)} \\ \hline \end{array}$ Sampled in the 2nd Quarter only 14.29 10.27 $10.77\,$ 275 273 4.18 $\frac{8}{20}$ \$.08 6.69 57 $\tilde{\mathbb{E}}$ 3.24 38 \$ $\overline{3}$ 7.63 7.15 724 7.46 719 249 739 725 6.98 $\frac{3}{2}$ 7.36 필 ឆ្ន 뚕 385 중 GROUNDWATER
ELEVATION
(FT NSL) 1548.80 1549.40 1548.48 $\frac{154.80}{2}$ 1892.05 1537.03 1550.62 1721.69 1568.98 1568.26 1545.72 1544.48 1587.27 1598.21 1591.21 1547.72 1548.67 1541.32 AQUEOUS
PHASE
LIQUID XOX. DEPTHTO (FET) 77.69 28.18 27.25 $21.29\,$ 19.12 $\frac{13}{2}$ $\frac{3}{2}$ 11.92 21.54 29.89 20.53 2,05 Ξ 26.91 $\overline{5}$ 58 ELEVATION TOP OF
CASING 1614.96 [618.46] [568.25] 1568.38 1552.05 1550.62 1598.87 1618.39 1595.17 1,567.01 1567.92 1567.83 1553.85 1550.46 1552.33 1548.95 (351) 1743.23 1566.97 ${\rm from}~{\rm TOC}$ TOTAL
DEPTH $22.0\,$ $20.0\,$ $3.0\,$ 50.00 349 ξÓ 38.0 $\ddot{\rm s}$ 28.0 50 \tilde{z}_0 $\mathcal{D}_{\mathbf{1}}$ \mathcal{G} \mathbb{Z}^2 S. 8 콲 \mathfrak{A} WELL# NW KS **MW-K4** M.IT PC₁₈ PC-53 PC-55 χ ic3 PC-59 ୂଷ୍ **PC-62 PC-68** PC 86 PC₃₀ PC-91 PC 92 PC 94 PC₃₅

Summary of Field Data for: 1st Quarter Groundwater Monitoring, February 2015 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada **TABLE 1**

COMMENTS/Analytical Plan/Temp pH TDS, Cr, CIO, pH, TDS, Ct, CIO, pH, TDS, Cr, ClO₃ pH TDS, Cr, CIO, pH, TDS, Cr, ClO₄ eH, TDS, Cr, CIO₄ pH, TDS, Cr, CIO, pH, TDS, Cr, ClO, pH, TDS, Cr, CID, pH, TDS, Cr, CIO, pH, TDS, Cr, ClO₄ pH, TDS, Cz, CIO₃ aH, TDS, Cr, ClO, pH, TDS, Cr, CIO, pH, TDS, Cr, ClO, pH, TDS, Cr, CIO. pH, TDS, Cr, CO₃ pH, TDS, Cr, ClO. MONITORING
QUALIFIER ² **Surdund** Strictund pumping **Puriping** Sandamd Brutubas TIME 120 $10:33$ 10% $9:18$ $\frac{3}{2}$ 936 9:38 $\frac{21}{4}$ $\S2$ 7.06 \tilde{c} Ş, 926 9:33 S. 634 $\frac{4}{30}$ Ş, 2/24/2015 24.20E5 2/4/2015 205045 2/24/2015 2/24/2015 2/24/2015 2/24/2015 2/12/2015 2/4/2015 24/2015 24:2015 2/12/2015 2182015 2/18/2015 242015 24/2015 24/2015 **DATE** $\begin{array}{c|c}\n\hline\n\text{SPECTNITY} \\
\hline\n\text{CONOLUTION} \\
\text{(mS/cm)}\n\end{array}$ 8.36 $\frac{8}{2}$ 32 9.62 9.89 $\overline{\mathbb{C}}$ 336 $\overline{5}$ $\frac{65}{2}$ हैं 7.34 754 7.19 6.95 $\bar{\Omega}$ 7.18 7.18 7.36 728 230 S. 7.66 735 7.35 $\frac{1}{1}$ ន្ត Ä g 퓧 $\begin{tabular}{|c|c|} \hline \texttt{GROUNMITB} \\\hline \texttt{ELFATION} \\\hline \texttt{F} \texttt{LMSL} \end{tabular}$ 1525.3 1601.40 1612.69 1524.16 (541.73 1541.22 1544.57 1550.47 1550.53 1595.39 1613.25 1615.92 1580.26 1594.53 1548.52 1522.99 1588.49 #REF! $\begin{array}{c}\n\hline\n\text{WEDS} \\
\hline\n\text{PHSE}\n\end{array}$ $\frac{1}{2}$ ×0× $\begin{array}{|l|} \hline \text{DEPH TO} \end{array}$ (EET) $\frac{3}{2}$ 18.41 $2.95\,$ $^{\rm 100}$ 2.98 10.88 22.63 25.04 $21.81\,$ 308 31.11 28.32 $\bar{2}$ $\frac{9}{4}$ 7.69 $\overline{=}$ $\frac{63}{2}$ \tilde{e} ELEVATION CASTNG 1548.53 1552.10 1552.36 1554.64 1554.10 163.73 1635.06 [634.33] 1632.42 1618.64 1,994.9 1618.02 1626.44 TOP OF 1593.35 1554.71 1554.66 1552.48 1554.53 (151) Irom TOC) TOTAL
DEFTH 34.70 \$4.60 $\boldsymbol{\mathcal{G}}$ $34.30\,$ 54.70 $\tilde{\mathbf{5}}$ 38.5 $\tilde{\mathbf{x}}^0$ $\dot{\mathbf{3}}$. Ω â 555 555 $53.0\,$ $\frac{1}{2}$ $\frac{8}{4}$ 53 \mathbb{S}^1 **WELL?** PC-JULK PC-LISR PC-116R PC_{99R} **PC-98R** PC-120 PC121 **PC-122** PC125 PC126 PC127 PC-103 PC₁₁₉ PC-123 PC-124 PC-117 PC-118 PC-97

Summary of Field Data for: 1st Quarter Groundwater Monitoring, February 2015 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada **TABLE 1**

COMMENTS Analytical Plan/Temp pH, TDS, Cr, CIO. pH, TDS, Cr, CIO₄ pH, TDS, Cr, CIO, pH, TDS, Ct, CIO₃ pH, TDS, Cr, CIO₂ pH, TDS, Cr, CIO₄ pH, TDS, Cr, CIO, pH, TDS, Cr, ClO, pH, TDS, Cr, CIO, pH, TDS, Cr, CIO, pH, TDS, Cr, CIO₃ pH, TDS, Cr, ClO_b pH TDS, C: CIO. 5H, TDS, Cr, CIO₄ pH, TDS, Cr, CIO, pH, TDS, Cr, CIO₂ pH, TDS, Cr, CIO. \mathbb{H} , TDS, \mathbb{C} , ClO₃ MONITORNG
QUALIFIER² geidend pumping TEME 10°N $11\,01$ $10 - 12$ 10:34 $\frac{5}{2}$ $10:51$ $10:27$ \mathfrak{D} $\frac{5}{21}$ 5:38 $604\,$ $\frac{1}{2}$ $620\,$ $730\,$ 9:08 $\frac{38}{25}$ $\frac{3}{2}$ $\frac{1}{2}$ 223:2015 223/2015 2772015 2232815 2262015 226:2015 2/3/2015 224/2015 2/24/2015 225/2015 2(2/2015 2/27/2015 224/2015 2/24/2015 2012015 225/2015 23/2015 24:2015 **DATE** $\begin{array}{|c|} \hline \texttt{SELECT} \\ \hline \texttt{CONDECINTY} \\ \hline \texttt{(nSum)} \\ \hline \texttt{(nSum)} \end{array}$ 16.13 13.38 13.66 5 5.98 212 $\dot{\rm s}$ ΰÇ, $\frac{4}{8}$ 5.07 4.89 \$53 L 7.57 8.21 \mathbb{C} $\tilde{\mathbb{Z}}$ 7.53 $\frac{4}{2}$ 7.68 6.99 7.30 23 7.12 729 g 747 725 750 Ĕ $\bar{\rm 2}$ P. 7.38 Ă 필 GROUNDWATER
ELEVATION
(FT NSL) 1546.19 1590.20 1720.68 1723.85 1725.92 1715.23 1613.95 1586.00 1586.74 1709.22 1614.81 1615.53 1622.34 1624.97 1589.24 1588.11 1,89.41 1709.21 $\begin{array}{|c|c|}\hline \text{XOC} \\ \hline \text{AQUEOUS} \\ \hline \text{PILSE} \\ \hline \text{LJQUID}^1 \\ \hline \end{array}$ DEPTHTO (111) 18.33 18.46 $30.52\,$ $27.76\,$ $\frac{1}{4}$ 43.12 43.66 19.26 32.04 39,52 32.35 3.29 29.47 11.24 29.34 28.91 9.87 6.81 TOP OF 1752.76 1618.58 1755.39 (758.35) 1752.87 1633.36 1618.04 1617.96 1618.93 1619.09 1753.93 1753.89 1633.99 1634.84 1553.00 1618.63 (MSD) 163338 1633.21 **NTERCEPTOR WELLS** iтет 10С) TOTAL
BEFTH $46\,$ $\tilde{\Omega}.0$ $5.00\,$ $45,70$ $\frac{45}{4}$ 37.70 39.10 39.70 $10\,$ $\rm s$ 39.7 54.70 19.70 $\frac{2}{3}$ $\frac{1}{2}$ $\frac{2}{2}$ 8 s, \$ WELL# PC-1354 PC129 PC130 PC₁₃₃ PC-136 **PO14** PC148 PC-149 PC-159 PC-128 PC-132 PC-13I \vec{A} $\frac{8}{2}$ \mathbb{R}^2 $\mathbb{R}^{\mathbb{C}}$ \mathbf{u} \tilde{z}

Summary of Field Data for: 1st Quarter Groundwater Monitoring, February 2015 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada TABLE₁

COMMENTS Analytical PlanTemp pH, TDS, Cr, CIO₄ pH, TDS, Cr, CIO, pH, TDS, Cr, CIO₄ pH, TDS, Cr, CIO₃ pH TDS Cr CIO4 pH, TDS, Cr, CIO, pH, TDS, Cr, ClO, pH, TDS, Cr, CIO, pH, TDS, Cr, CIO_s pH, TDS, Cr, CIO, pH FDS, Cr, CIO2 pH, TDS, Cr, CIO, pH, TDS, Cr, ClO₄ pH, TDS, Cr, ClO, MONITORING
QUALIFIER² TIME 10:15 $\frac{9}{9}$ $\frac{33}{2}$ $11:30$ $\frac{43}{42}$ $\S 22$ K 9:00 $\frac{4}{6}$ $\tilde{\Sigma}$ $\tilde{\mathbb{S}}$ 925 $\frac{38}{2}$ 8:08 845 $\frac{1}{2}$ $\overline{9}$ 9:43 2/23/2015 223/2015 223/2015 2/37/2015 226/2015 2/33/2015 223/2015 223:2015 223/2015 2232015 2/23/2015 2030015 2/26/2015 223/2015 223:2015 2:23:2015 2/23/2015 2,30015 DATE $\begin{bmatrix} \texttt{SELECT} \\ \texttt{CONDUCINTY} \\ \texttt{(mSum)} \\ \texttt{(mSum)} \end{bmatrix}$ $10.14\,$ 14.68 11.89 10.04 10.36 11.72 $\mathbf{\hat{5}}\mathbf{\hat{5}}$ 11.97 71 $\frac{51}{2}$ $7.63\,$ \mathfrak{D} 8.57 863 9.68 935 739 23 728 6.75 6.99 7.07 $\frac{\pi}{2}$ 6.87 g 2.08 $\frac{3}{2}$ 695 \mathbb{R}^2 7.12 6.96 ă 7.45 $\frac{3}{2}$ 594 $\bar{\rm n}$ 필 GROUNDWATER
ELEVATION
(FT MSL) 1708.49 1717.06 1720.74 1107.83 1717.56 1718.44 1709.22 1719.03 1707.93 1711.72 1715.02 1721.21 1711.37 1709.12 1721.26 1709.92 1710.59 1713.11 $\begin{array}{|l|}\n\hline\n\text{XOC} & \text{XOC} \\
\hline\n\text{AQUEOUS} & \text{PILASE} \\
\hline\n\text{LIOUD} & \text{I.}\n\end{array}$ DEFIETO¹ (FET) 42.13 43.17 $\frac{43}{1}$ 28.96 41.13 36.12 39.97 $\frac{3}{2}$ 37.77 41.07 $40,00$ $28\,\%$ 33.64 4.09 24.24 -2.26 $35.71\,$ 5.01 $\begin{array}{|c|c|}\n\hline\n\text{ropo}&\text{csc} &\text{csc} &\text$ 1752.77 1745.50 1750.09 1751.69 1752.90 1751,35 1750.03 1752.67 1732.36 1749.70 1752,50 1746.04 1752.79 1751.66 1753.11 1751.45 1751.66 1753.21 (MSL) from TOC TOTAL
DEPTH 46 TO 44.80 43.40 41.70 (3.80) 45.30 47.70 17.80 $+3.80$ 47.70 45.80 46.50 44.20 40.60 43.70 43.80 57,80 42.60 WELL# \vec{z} $\widetilde{\mathcal{L}}$ $\tilde{\Delta}$ \overline{a} $\tilde{\Xi}$ Ê $\dot{\mathbf{r}}$ 문 ĚK. 보 오 \mathbf{r} \Box \simeq \mathbf{S} Ξ $\overline{\mathbb{Z}}$ 2

Summary of Field Data for: 1st Quarter Groundwater Monitoring, February 2015 Well Inventory for Groundwater Sampling
NERT Project, Henderson, Nevada TABLE 1

Summary of Field Data for: 1st Quarter Groundwater Monitoring, February 2015 NERT Project, Henderson, Nevada

Well Inventory for Groundwater Sampling

TABLE 1

Montaly
3rd week NOTES:

Monthly Ist
week

T

-ł

 \blacksquare

Τ

T T Τ

7 Τ Т

Neces have to see

Δ

 $\overline{}$ DateTime
DateTime Date Time Company: Company: Company Received by $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ Received by: Received by: $\tilde{\chi}$ استنتهها
البرازيمان Date Fine Dale Tane Company
El) (): roger Company: Company: **MEXI** $\frac{|\mathcal{V}|}{|\mathcal{R}|\mathcal{V}|}$ Relinquished by: od potskabak:

TestAmerica

Irvine, CA 92614

Natural properties Saate (0)

Chain of Custody Record

PestAmerica Laboratories, Inc. $\frac{1}{2}$ estate i 1980 1980 i 1980
Sampo Ostrosa i 1980 i 19 N) Collable Fort Months $\frac{1}{\sqrt{2}} \sum_{n=1}^{\infty}$ Dae Tree 30C X0 ါ
အမော Date Time. Job No. 회 Tensito the validity and account of the (these) samples in the construction of the control of the con li
G Company Compant Carrier: .
Beie: Lab Contact: Sushmitha Reddy con: Recording to the Contract of Site Contact: Wendy Prescott TON TARD 'H^d 'SO. FON HE'SCO LANCE FROM SALE nd 'sou .
. s. Récenediby Received by FON. $\ddot{}$ i. $\overline{}$ ī. \overline{a} 4, ., **HINORILD TIVLO.** \Rightarrow w ų, N, \rightarrow olquing borolfs Š. 3
6
0 ζ^\vee ζ^\vee $\mathcal{C}^{\mathcal{C}}$ \sim \mathcal{N} ∞ $\langle \mathbf{Y}^{\prime }\rangle$ N M ەسى Calendar (C) or Work Days (W) WORK **REFERENCE**
PROJEK Date Time $\sqrt[n]{\sqrt[n]{\omega}}$ xorma where **NORMAL** WATER $C(7)$ xormly witer NORMAL **WATER** $|CO33|$ Normal Natire $\begin{picture}(20,10) \put(0,0){\vector(1,0){10}} \put(15,0){\vector(1,0){10}} \put(15,0){\vector(1$ $\mathbb{C}[\mathbb{R}]$ \mathbb{R} \mathbb{R} \mathbb{R} \mathbb{R} $|\mathbb{C}^{k, \mathbb{C}}_{\cdot}|$ Normal water Satrax $|\mathcal{C}(\hat{\mathbb{C}})|$ rorial water $\overline{C^s}$. $\log_{ML}{\rm [ware]}$ Date Time **CELL** NORMAL WATER **NORMAL** WATER Analysis Turnaround Time Project Manager: Wendy Prescott Sangle TAT and flerent hasts Below i.
Pr 2 weeks 2 as β l week $\frac{1}{2}$ $\frac{\sum\limits_{\text{Compins.}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text{Comp}}\sum\limits_{\text$ Tel Fam 101 171 9307 Sample : $\frac{1}{2}$ 325665 $\frac{1}{\sqrt{2}}$ ine. reservation Usef: 1= $\log_2 2 = \text{HCS}$, 1= HISC , $\epsilon = \text{HVO}$, $\epsilon = \text{NaOL}$, 6= Oher Sanple 1 \cup $\Box \Box \Box$ $\bar{\rightarrow}$ Company \equiv Sim Irrians Ster NERT- 510 S. Fourth St., Hoederson, NV 89015 REEDS LEVEL 4 REPORT Special Instructions/QC Requirements & Comments: Brown Sample identification Project Name: NERT- 4th Quarter M Wells Client Cortact \Box Rammable $\sum_{i=1}^{n}$ $\frac{1}{\sqrt{2}}$ phone 949,261.1022 fax 949.268.3299 $\frac{1}{\sqrt{1-\frac{1}{2}}}$ $\frac{1}{\left|\frac{1}{1-\beta}\right|}$ $\frac{1}{2}$ こい $\frac{1}{\sqrt{2}}$ $\begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix}$ سا
اسا
الهس∲ $\frac{2}{1}$ Ñ rende Here i lenifenten Envirogen Technologies 510 South Fourth Street Henderson, NV 89015 rdas, CA 92614 $\overline{\mathbb{C}}$ hon Hazard Equated by 702-371-9507 ୍ୟୁ Refinquished by: Ralinguisad by $204,383$ $\frac{1}{2}$

Suite 109
Irvine, CA 926 14

Chain of Custody Record

IAGE Death Ave INTIRE, CA 92614 Suite 100

Chain of Custody Record

TARASHI

Test-merica Laboratories, Inc. Date Time
|
| Date/Time Date Time COC No. **BOO Job No.** $\boxed{\omega}$ *iya-kazari* $\boxed{\Box}$ Rammable $\boxed{\Box}$ Sin Frincii . Possen B $\boxed{\Box}$ (independent $\boxed{\Box}$ Related To Client $\boxed{\Box}$ Desposal By Laboration of the Hammable . The Since the Relation of the Since the Lie of the Clien Company Company. Company Carrier: Date: Ŋ Lab Contact: Sushmitha Reddy appeak). Site Contact: Wendy Prescott _{Return To Client} $O(N) \gg P - \gamma_{12} \Omega_2$ いいいし munimority leteT V.002 \sim $\frac{1}{2}$ Received by: HI 00SF MS Received by этелогизала отред $\frac{1}{2}$ $\frac{1}{1}$ Ξ Ţ ı. ÷. Ŀ. 2540C_Calcd-Totul Dissolved Solids siqmes bataili¥ $\frac{1}{3}$ $\frac{1}{6}$ $\boldsymbol{\epsilon}$ ϵ^{μ} $\ddot{}$ $\ddot{}$ $\frac{1}{2}$ $\tilde{\mathcal{C}}$ α $\ddot{}$ \mathbf{r}^{\star} ϵ^2 \hat{G} $\frac{1}{2}$ Calendar (C) or Vierk Days (W) WORK Date/Time Date Time Date Time slaufx **CAME NORMAL WATER** OB² NORMAL WATER **SROO** NORMAL WATER 3345 PRG NORGAL WATER **COM** NORMAL WATER $\mathcal{O}31$ sorger water <u>grzy norski mater</u> **CYD** SORISAL WATER 0716 NORMAL WATER 0039 NORMAL WATER 0559 NORMAL WATER OUST MOREAL WATER Analysis Turnaround Time $\lim_{n\to\infty}\frac{1}{n^2}\sum_{i=1}^{n}\frac{1}{n^2}\sum_{i=1}^{n}\frac{1}{n^2}$ Project Manager: Wendy Prescott \square Universe \square Sample ្លុង
ស្រុ TAT déficant four Below 2 weeks $2 \; \rm{days}$ l seek \ddot{a} ğ TelFac: 702-371-9307 Neels level y report Sample Time Preservation lised: $j = i\alpha$, $2 = HC$, $3 = H2SO4$; $4 = HNO3$; $5 = N2OH$; $6 = Other$ Company
EQN
Company Sample
Date \Box $\Box \ \Box \ \Box$ Company: C) Project Name: Envirogen-Monthly ARP and PC Wess pg Sile: NERT-510 S. Fourth St., Hnederson, NV 89015 さいこと Special Instructions/QC Requirements & Comments: Sample Identification Cilegt Contact $(26 - 12)^{n}$ phone 949.261.1022 fax 949.260.3299 22 130 $24 - 148$ $\frac{1}{2}$ $PC - 13.2$ $20 - 124$ ici Dà どく こう **ASI-DO** pe as 经月8 \mathcal{M} and Possible Hasard Identification Y 5:0 Scuth Fourth Street Envirogen Technologies Renderson, NV 89015 $\frac{1}{2}$ Relinguised by: Retraguished by: Reliequished by 702-371-9307 PO#3683 FAX

 $O_{\text{bin of } C}$

Ä

í.

Suite 100

Suite 100
Irvine, CA 92614

Technolica

.........
17461 Derian Ave
Suite 109
Invine, CA 92664

TestAmerica Laboratories, Inc.

Body: Monatomation: Press, 2008.

1/26/2015 11:59:00PM 3/21/2013 4:10:10PM NERT - Quarterly 1st Sushmitha Reddy In Process Lab Project Number: 44008216 Request From Client: 1/2/2015 4303 Date Order Posted: Deliver By Date: Bottle Order # Order Status: Prepared By: Bottle Order:

Order Completion Information Hard Separation and Sushmitha Reddy Creator:

Tracking # Sent Date: Sent Via: Filled by:

CAUTION! STRONG OXIDIZER! CONTAINS 1:1 NITRIC ACID. Avoid skin and eye
contact. If contact is made, FLUSH IMMEDIATELY with water. Comment 'n Preservative

Nitric Acid

* * * * * * *
p * * * * * *
<u>8 8 8 8 8 8 8</u> Company Company Received By Received By Ĕ Time Date Date Company Company Reinquished By Reinquished By

Printed on 1/21/2015 5:24:19PM

Please notify us immediately if an error is found in shipment

Page 2 of 2

Bottle Order Information 2008 (See Fig. 2008) Bottle Order:

3/21/2013 12:00:12PM NERT - Quarterly M-10 Order Status: In Process
Prepared By: Sushmitha Reddy
Deliver By Date: 1/6/2015 12:00:00AM
Lab Project Number: 44008210

Request From Client: 1/2/2015

Date Order Posted:

4296

Bottle Order #

Order Completion Information and the state of the state eddy

T T

Ţ

Τ

Please notify us immediately if an error is found in shipment

Page 2 of 2

Groundwater Field Log

This Section Contains:

• Water Sampling Field Logs

Table of Well Gauging Data

This Section Contains:

- Field Sign In Log
- Daily Maintenance & Calibration Log
- . Table 1 Well Inventory
- Chain-of-Custody & Bottle Order Forms

Project No.:

 $\Delta \sim 10^4$

Well No.: ARP-2A

Well No.: ARP-3A

 $\Delta \mathcal{V}$.

Well No.: ARP-4A

WEIND. ARP 5A

 α $\frac{3}{2}$

 $\bar{1}$

 \sim

Comments:

 $\overline{}$

comments: Well capped - NO data

TOTAL Bottles-

í.

TOTAL BOTTLES: \overbrace{C}

Comments:

 $\sim 10^7$

Water Sampling Field Log $L - (037)$ Well No.: Site: NERT PROJECT- HENDERSON, NEVADA <u>Project No.:</u> $2-11-15$ Sampling Team: Michele Brown Date: Sampling Method: Electric Pump O Dedicated Bailer O Non Dedicated Bailer O Ready Flo 2" O **Weather Conditions:** 10)M Mi **Well Information:** Time: 1235 Total Well Depth: feet Depth to Water: feet Well Purge Purge Well Diameter (circle one)
2-in. 4-in. 6-in Volume (WV) Factor Volume Height of Water Column (L): feet * 0.16 gal/ft * 0.65 gal/ft * 1.47 gal/ft $=$ gal. * $3 =$ **Field Measurements:** Depth Purging From: 2 ft. below depth to water **Cumulative** Volume Specific Time Purged pН Conductivity Temp **Observations** $\overline{}$ ------ $--- -$ ---gal γ えころうかA gal gal No sample gal gal gal Sample Appearance: Sample Collection -Time Start: Time Finished: **Communist Communist Property** Analyses: CLO4 pH/TDS **CR** Bottles:

TOTAL BOTTLES:

Comments:

1 BTL

 $1 BTL$

 $1 BTL$

Top of screen-43'

 $\label{eq:2.1} \frac{1}{\sqrt{2}}\int_{\mathbb{R}^3}\frac{1}{\sqrt{2}}\left(\frac{1}{\sqrt{2}}\right)^2\frac{1}{\sqrt{2}}\left(\frac{1}{\sqrt{2}}\right)^2\frac{1}{\sqrt{2}}\left(\frac{1}{\sqrt{2}}\right)^2.$

 $\mathcal{L}^{\text{max}}_{\text{max}}$ and $\mathcal{L}^{\text{max}}_{\text{max}}$

 $\sim 10^{11}$ km s $^{-1}$ km s $^{-1}$

Top of screen - 24 Comments:

 \bar{z}

 $\sim r^2$

 $\mathcal{L}^{\text{max}}_{\text{max}}$ and $\mathcal{L}^{\text{max}}_{\text{max}}$

 $\hat{\boldsymbol{\beta}}$

comments: Top of serven - 175'

 $\sim 10^{11}$ km s $^{-1}$

 $\mathcal{L}^{\text{max}}_{\text{max}}$

TOTAL BOTTLES: $\frac{3}{5}$

1 BTL

<u>1 BTL</u>

<u>1 BTL</u>

 \sim

 $\mathcal{L}^{\text{max}}_{\text{max}}$

 $\mathcal{L}^{\text{max}}_{\text{max}}$ and $\mathcal{L}^{\text{max}}_{\text{max}}$

TOTAL BOTTLES: $\overbrace{\text{ } }$

Comments:

 $\sim 10^6$

 $\mathcal{L}^{\text{max}}_{\text{max}}$, where $\mathcal{L}^{\text{max}}_{\text{max}}$

 \mathcal{A}

 $\sim 10^{11}$ km s $^{-1}$

Comments: Top of screen - 35.4

Water Sampling Field Log -95 Well No.: Project No.: Site: NERT PROJECT- HENDERSON, NEVADA 2-24-15 Sampling Team: Michele Brown, Date: Sampling Method: Electric Pump [®] Dedicated Bailer O Non Dedicated Bailer O Ready Flo 2" O $(0 0 0 0 1)$ **Weather Conditions:** Well Information: Total Well Depth: 30.0. feet Time: $\sqrt{2}$ <u>7.93</u> Depth to Water: feet Well *X*Vell`ิ Diameter (circle one) Volume (WV) $2 - in$ $4 - in$. КJ. 1207 93 gal. $*$ Height of Water Column (L): 16 gal/ft feet 1 * 0.65 gal/ft * 1.47 gal/ft $\times 3$ la Gol **Field Measurements:** Depth Purging From: 2 ft. below depth to water **Cumulative** Volume **Specific Time** Purged Conductivity рH Temp **Observations** $1\vert \lambda \rangle$ $\frac{1}{2}$ ----------- 233° 0000 1123 742 R 20 msr.m dal 784.1^{40} 1125 7.30 9.18 mskm gal 30.8 ° 1128 7.27 $71.22 m$ Юm \overline{a} gal $\ell_{\ell\alpha\ell}$ Sample Appearance: Time Start: $\frac{1}{2}$ $\sqrt{3}$ \circ 1130 Sample Collection -Time Finished: pH / TDS ์ H / TDS / CRVI Analyses: CLO² ĆR pH / TDS / CRVI / NO3 pH / TDS / NO3 CLO₃ Bottles: $1BTL$ $1B$ **BT** 1 BTL 1 BTL $1 BTL$ $1BTL$

TOTAL BOTTLES:

 $12'$ TOP OF Screen. Comments:

comments: Top of screen - 10.5

comments: Top of screen-35

comments: Top of screen - 19

 $\sim 10^{11}$ km $^{-1}$

Comments:

Comments:

Comments:

Comments: Top of screen-21.7

Ċ,

Water Sampling Field Log M-169 Well No.: Project No.: Site: NERT PROJECT- HENDERSON, NEVADA 2-16-15 Sampling Team: Michele Brown, Date: Sampling Method: Electric Pump O Non Dedicated Bailer O Dedicated Bailer O Ready Flo 2" O () M 1 **Weather Conditions: DATM Well Information:** Time: 1002) Total Well Depth: feet Depth to Water: ⊃feet Well Well Diameter (circle one) Volume (WV) $2-\pi$ 4-in. к. н. 8≎،ها Height of Water Column (L): feet * 0.65 gal/ft * 1.47 gal/ft 16 gal/ft ₩ gal. * x_3 **Field Measurements:** Depth Purging From: 2 ft. below depth to water Cumulative Volume **Specific** Time Purged рH Conductivity Temp **Observations** $-- \mathbf{u}$ gal)TC € gal and the company ND 142 gal Sample Appearance: Sample Collection -Time Start: Time Finished: _______________ Analyses: CLO4 pH / TDS **CR** pH / TDS / CRVI pH / TDS / CRVI / NO3 pH / TDS / NO3 CLO₃ Bottles: $7BTL$ $1 BTL$ 1 BTL $1 BTL$ $1BTL$ $1 BTL$ $1BTL$ **TOTAL BOTTLES:** Of screen-24.7 Comments:

Comments:
\mathbf{r}

 $\sim 10^{11}$

....

L

 \overline{a}

 \sim

 \sim

 $\bar{1}$

Well No. MW1<4

 $\mathcal{L}^{\text{max}}_{\text{max}}$

 $\sim 10^{11}$ m $^{-1}$ m $^{-1}$

Well No.: $PC-18$

 S Comments: S CFEEN $II.5 - 51.5$

 $\sim 10^{11}$

Comments: $\bigcup_{i} L(C(C_i) \cup D_i)$

Water Sampling Field Log 71 - 55 Well No.: Site: NERT PROJECT- HENDERSON, NEVADA Project No.: $2.13 - 15$ Date: Sampling Team: Michele Brown Ready Flo 2" O Non Dedicated Bailer O Dedicated Bailer O Electric Pump \bullet Sampling Method: Weather Conditions: **Well Information:** Time: 1030 Total Well Depth: feet S Purge Well Purge λ foet Depth to Water: Volume Factor Well Diameter (circ) one) Volume (WV) $2 - 10$ 4-in. 6 in 28.15 Ļ 41.ZX 3 1.47 gal/ft aal. feet * 0.16 gal/ft * 0.65 gal/ft Height of Water Column (L) Depth Purging From: 2 ft. below depth to water **Field Measurements:** Cumulative Specific Volume **Observations** Conductivity Temp Purged pН Time

Clou orly

Screen 4.8-54.8

Comments:

 $screen$ $9.8 - 32.8$

comments: Sereen 4.5 - 39.5

 $\sim 10^{11}$ km

comments: $SCFECN$ $1.6 - 57.6$

Well No.: $PC-LO$

Comments:

 \cdot

 $\mathcal{L}^{\text{max}}_{\text{max}}$ and $\mathcal{L}^{\text{max}}_{\text{max}}$

 $\sim 10^{-11}$

Comments:

ć,

 $\hat{\boldsymbol{\beta}}$

 ϵ

 $\left\{ \right.$

Well No.: PC-101R

TOTAL Bottles- \overrightarrow{S}

TOTAL Bottles- $\frac{3}{5}$

TOTAL Bottles- 5

 \sim

TOTAL Bottles- 3

Well No.: $PC-122$

k,

Water Sampling Field Log PC - $\sqrt{27}$ Well No.: Project No.: Site: NERT PROJECT- HENDERSON, NEVADA Sampling Team: Michele Brown, Date: ふー ユー Sampling Method: Electric Pump [@] Dedicated Bailer O Non Dedicated Baller O Ready Flo 2" O **Weather Conditions:** ſ. Λ Ω Well Information: Total Well Depth: 34 TO feet) 152 Time: (Depth to Water: feet Well Well Diameter (circle one) Volume (WV) $2 - in.$ 4π n 6 ਨ Height of Water Column (L): (QQC) feet 20.16 gal/ft <u> 8 gal</u> 0.65 gal/ft * 1.47 gal/ft $=$ 2.1e0 gal. * \times 3 **Field Measurements:** Depth Purging From: 2 ft, below depth to water Cumulative Volume **Specific** Time Purged рH Conductivity Temp Observations ഗ്വാ фĊ ጣ ĻC <u>സ്</u> a . " gal W ΛU 0 øС D gal c ōC ଧା gal ها ،

Comments: Top of screen-14.8

ىب en $1 - 7 - 8$ ∽ ~ c

Water Sampling Field Log $PC - 131$ Well No.: Project No.: Site: NERT PROJECT- HENDERSON, NEVADA $2 - 24 - 15$ Sampling Team: Michele Brown. Date: Sampling Method: Electric Pump @ Dedicated Bailer O Non Dedicated Bailer O Ready Flo 2" O Weather Conditions: 0 いしいじゅう Well Information: Total Well Depth: $Time: 053\%$ feet Depth to Water: feet Well <u>Well Diameter (circle one)</u> Volume (VVV) $2 - \overline{n}$ 4-in. 8. n Height of Water Column (L): Q_8 | Q_9 4.50 gal. \star feet * 0.65 gal/ft * 1.47 gal/ft 0.16 gal/ft $\times 3$ **Field Measurements:** Depth Purging From: 2 ft. below depth to water **Cumulative** Volume **Specific** Time Purged pН Conductivity Temp Observations o C スマ gal 32 € STO οċ Ю 1352 gal n G S o C 1366 132 aal Ä lea Sample Appearance: Sample Collection -Time Start: 0.956 Time Finished: $055/$ Analyses: -O4 bH ⁄ TD\$ CR pH / TDS / CRVI pH/TDS/CRVI/NO3 Bottles: pH / TDS / NO3 CLO₃ BΤ **BTL** $1BTI$ 1 $1 BTL$ $1BTL$ 1 BTL 1 BTL ు **TOTAL BOTTLES:** of screen-9.8 Comments:

Too

Water Sampling Field Log PC-132 Well No.: Site: NERT PROJECT- HENDERSON, NEVADA Project No.: ふ -スナーいづ Date: Sampling Team: Michele Brown, Ready Flo 2" O Dedicated Bailer O Non Dedicated Bailer O Sampling Method: Electric Pump [®] DO $(A \wedge A)$ めいびん **Weather Conditions: Well Information:** 39.70 Time: $O\&O$ 4 feet Total Well Depth. a xt Depth to Water: feet Well Well Diameter (circle one) Volume (WV) $74 - in.$ 6-ार्ग $2 - \overline{n}$ $x3 - 14$ -29.82 = 4.77 gal. * Height of Water Column (L): 46 gal/ft 0.65 gal/ft feet : * 1.47 gal/ft **Field Measurements:** Depth Purging From: 2 ft. below depth to water Cumulative Volume **Specific Observations** Time Purged Hq Conductivity Temp ⊘ക 5 $O(612)$ ণ ২৪ gal $O(Q_1)$ \overline{O} りっく gal 13.37 mSkm いい 0623 ገ፡32 gal θ Ω_{Ω} Sample Appearance: Time Finished: \bigcirc \bigcirc \bigcirc \bigcirc Time Start: (21025 Sample Collection pH / TDS / CRVI / NO3 pH / TDS / NO3 CLO₃ CR pH / TDS / CRVI Analyses: CLO4 / TDS 1_{BTL} $1 BTL$ 1 BTL 1 BTL Bottles: **BTI** BTL $\overline{\mathsf{BT}}$ **TOTAL BOTTLES:** Comments:

Top of screen. 9.8'

 \cdot

comments: Top of screen - 21.0

 $\sim 10^{-11}$

TOTAL Bottles- $\overline{\bigcirc}$

Field Measurements:

 \sim

Well No.: I A

 \overline{a}

j.

 \bar{q}

<u>1028 5.98msfor 21200 716 Clear</u>

Bottles: 3 Bottles

Field Measurements:

Field Measurements:

 \sim

Field Measurements:

Field Measurements:

Support

 $\ddot{}$

Field Measurements:

Comments:

 $\bar{\ell}$

Comments:

 $\overline{}$

 \bar{z}

 ϵ

Field Measurements:

Field Measurements:

 $\sim 10^{-1}$

 $\hat{\theta}_0$

Field Measurements:

Comments:

 $\mathcal{A}^{\mathcal{A}}$

Second Quarter VVell Monitoring

NSVEIS ENVIRONINGINGI Kabponse Irusi ilendereon, Nevada

May 4, 2015 thru June 5, 2015

CONTENTS

Field Data Letter Report

Section

Letter of Transmittal

Date: July 20, 2015

Attention: Andrew Harley, PhD Principal Geochemist Mine Water Management Lead Tetra Tech 350 Indiana Street Suite 500 Golden, Co 8040 I

Project:

2015 2nd Quarter Groundwater Monitoring

Enclosed:

1 copy of Field Data Letter Report

Remarks:

Andrew,

The enclosed Quarterly Groundwater Monitoring Report with supporting documents is provided for your records.

 $Signature: WourU1(A01006)$

Wendy Prescott

Envirogen Technologies Two Kingwood Place 700 Rockmead Drive Suite 105 Kingwood, TX 77339

Quarterly Groundwater Monitoring Report

Nevada Environmental Response Trust (Former Tronox LLC Site) Henderson, Nevada

Responsible Certified Environmental Manager (CEM) for this project

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and, to the best of my knowledge, comply with all applicable federal, state and local statutes, regulations and ordinances.

JEGE LAWBETH

Comber

Jeff Lambeth Certified Environmental Manager Envirogen Technologies CEM Certificate Number: 2391 CEM Expiration Date: March 24, 2017

The following individuals provided input to this document:

Wendy Prescott, Project Manager, Envirogen Technologies Michele Brown, Lab Analyst 1, Sampling Tech, Envirogen Technologies Tobin Walker, OM Operator, Envirogen Technologies Nathan Eames, OM Operator, Envirogen Technologies Janel Rivera, Sampling Tech, Aerotek

Field Data Letter Report

1 INTRODUCTION

Nevada Environmental Response Trust (NERT) contracts with Envirogen Technologies to conduct groundwater sampling and analysis at their Perchlorate Removal Facility, located at 510 Fomth Street, in Henderson, Nevada. The work described herein represents the second quarter groundwater sampling event for 2015. The work was conducted in accordance with the Sampling and Analysis Work plan, submitted to Tronox January 9, 2004. Envirogen has three staff members trained to assist the quarterly well monitoring events. The Envirogen monitoring team meets once prior to the sampling event to discuss all issues associated with this project, sampling and laboratory equipment needs, time tables and well site schedules. Bottle orders and bottles received are cross checked to ensure that all wells and analysis are represented.

1.1 SCOPE OF SAMPLING EVENT

This sampling effort included the following tasks:

- Soundings of the pumping water levels in 27 interceptor wells.
- Soundings of the water levels in 3 dormant interceptor wells
- Collection of groundwater samples from 30 interceptor wells.
- Soundings of water levels in 196 monitoring wells.

2

- Collection of groundwater samples from 164 monitoring wells.
- Collection of groundwater samples from 18 pumping wells.
- Collection of groundwater water samples from 2 PC wells not online.
- Soundings of water levels in 6 backup (Buddy) wells.
- Soundings of water levels in 18 pumping wells.

Analysis of samples collected from the interceptor and monitoring wells, range from Perchlorate (CL04), Total Chromium (Cr), Hexavalent Chromium (CRVI), pH, Specific Conductance (EC), Total Dissolved Solids (TDS), and NPDES list for well M-10, (Up Well). CR, MN, FE, B, Ammonia, TIN, Nitrate-Nitrite as N, and Chloide. RCRA well analysis also included Conductance, TOC, TOX and Total Phenols.

Groundwater samples were shipped daily to TestAmerica (T A) for analysis, in Irvine, California. TA is certified by the State of Nevada.

The scope of this assignment also included compiling the water level and analytical data presented in this report. Data are presented in tabular form.

2 FIELD ACTIVITIES

Envirogen conducted the field activities associated with this quarterly sampling event between Monday May 4th and Tuesday July 14th, 2015. Activities included the sounding of"pumping water" levels in the interceptor wells, sounding the "static water" level in the monitoring wells and sampling of both the interceptor and monitoring wells. Prior to each quarter, an inventory list was issued to Environ for review and comment. Sampling was conducted according to their specifications.

Wendy Prescott and Michele Brown were responsible for sample collection and recording all pertinent data on sample bottles. Michele Brown supervised the groundwater sampling activities. She is responsible for executing all work elements related to the groundwater sampling program,

including laboratory equipment maintenances and calibration, fieldwork, documenting field activities, maintaining field notes and photographs (when applicable), and providing the Operations Manager with information concerning implementation of the sampling plan.

Envirogen maintained records of daily events and petiinent sampling data of each well on a field log sheet and addendum data in a bound log book. Log sheet entries included personnel onsite, weather conditions, water levels, activities conducted, sampling times, pH, EC, temperature and other significant field information.

2.1 Groundwater Level Soundings

Envirogen sounded pumping water levels in 27 interceptor wells. The static water readings were taken in Interceptor wells l-AB, I-AD and l-AC. In addition to the interceptor wells, static water levels in 194 monitoring wells were taken. There were thirty-two (30) wells where only static water levels were taken. The following are the 30 wells:

The water levels were sounded to the nearest 0.01 foot using an electronic well sounder.

2.2 Eguipment Cleaning Procedures

During the collection of water samples, throughout the day, the equipment was washed with soapy water and rinsed with 3 to 4 gallons of de-ionized water after use at each well. The rinse water was collected in a polyethylene container and transported to GW-11 for treatment.

3.0 GROUNDWATER SAMPLING

3.1 Sampling Locations

The following presents the identification of wells sampled.

3.1.1 Interceptor Wells

3.1.2 Pumping Wells

3. 1.3 **Monitoring Wells**

4

4.0 SAMPLING TECHNIQUES

4.1 Interceptor Wells

All interceptor wells were sampled using dedicated sampling ports. At the beginning of sampling each well or line, personnel wore a new pair of clean nitrile or latex gloves. The sampling port was opened to drain any stagnant water from piping and valves. This water is captured and containerized. All captured water is off-loaded at GW-11 for onsite treatment. Following the purging of the sample port, a "water quality" sample was collected for analysis of Perchlorate, Total Chromium, pH, and TDS. Envirogen also recorded the *"field'* temperature, pH, and conductivity as well as the pumping water level. The *"field'* parameters are provided in Table 1.

4.2 Monitoring Wells

Monitoring wells were purged before sampling to assure that each sample was collected from fresh formation water.

One hundred fifty six (154) wells were purged and sampled, using the 12 volt submersible pump. One (I) well M-6A was sampled with a dedicated bailer. Nine (9) wells were sampled using a non-dedicated disposable bailer, ART-6, H-28A, HM-2, M-7B, M-77, M-99, PC-74 and ART-7 A, were not purged due to location and/or water column level but samples were collected. Hand bailing was done as a result of only needing to purge less than 3 gallons of water, if there was an insufficient amount of water in the well casing to use a pump or due to the location of the well. M-32 and M-33 were purged and sampled using the disposable bailers.

Samples for both the interceptor and monitoring wells were collected in appropriate containers supplied by TestAmerica and analyzed for the specific required analysis of the well. The bottles were filled with minimal aeration, using laminar flow.

The samples were labeled, packaged, stored, and transported using the procedures outlined in the work plan for well samples. .

4.3 Problems Encountered

ART-7- well capped no data or sample collected

Not found- BEC-1, HSW-1, DM-4, DM-5

 $H-11$ – cap on outside casing stuck was not able to pry off or remove

H-48- Outside casing lid cross threaded not able to remove

HMW-13 – well PVC casing broken \sim 3' from top

No Access- L-635, L-637

M-29- not sampled due to safety

M-36- destroyed

M-93 – bailer stuck in well pump well not decent

M-140- No hole in well casing lid to insett probe to collect DTW reading

M-145- Sample was black, well located flush with street on east side of unit 6 in Tronox. Well full of Manganese

PC-94- No cast lid

PC-95-P&A

MC-3, MC-29, PC-40 samples for EC readings were diluted with Deionized water after pH $\&$ Temp readings were collected. 10 ml sample 10m! DI

M-32 and M-33 were sampled at a much later date as data was not readily available.

4.4 Equipment Cleaning Procedures

The deionized water is changed each morning so the rinsing water is fresh. Non-dedicated sampling equipment has been replaced by disposable bailers. Conductivity/pH meter probe was thoroughly rinsed with de-ionized water after each sample was analyzed. Pumping equipment was purged with deionized water to flush and clean before leaving to sample at the next location. Dedicated tubing was installed in each well to ensure no cross contamination from other wells occurs.

5.0 **QUALITY CONTROL**

Quality control (QC) procedures include collection and analysis of QC duplicate samples, equipment and field blanks. The analytical laboratory is also required to meet specific QA/QC requirements for surrogate recovery, MS/MSD recovery and RPDs, and LCS recoveries. Duplicate SC readings were conducted at one well each day to insure the accuracy of the Hanna field probe.

5.1 OC Duplicate Samples

QC duplicate samples were collected during the sampling event to evaluate the precision and accuracy of analytical data. The QC duplicates were collected, packaged, and transported in the same manner as the primary sample, but assigned a different identification number. Seven (7) duplicates were collected from the wells, representing at least 5 percent of the samples collected. The duplicate samples were collected from the following wells: M-66, PC-144, PC-148, M-25, M-44, M-124 and M-10. They were analyzed for the same parameters as the primary samples. TestAmerica was not informed of the identity of these "blind" samples.

5.2 Equipment Blanks

Seventeen (17) equipment blanks were taken this quarter. Four of the equipment blanks, for CLO4, TDS, CR, CRVI and pH analysis, were collected on May $5th$, $6th$, $7th$, $8th$, $14th$, $19th$, $20th$ 21st, 22nd, 26th, 27th, 28th, 29th, June 2nd, 3rd and the 5th, 2015. One equipment blank for CLO4 analysis only was collected on 5/21115. This is done to evaluate the adequacy of cleaning procedures used by field personnel during this sampling event.

5.3 Field Blanks

Two (2) field blanks were collected this quarter. Analysis included CL04, TDS, CR, CRVI and pH. These blanks were collected on May $8th$ and $27th$, 2015.

6.0 ANALYTICAL PROCEDURES

The following designates the parameter, analytical method and method reporting limits for groundwater. Some of the following analysis may not have been performed for this reporting period.

6.1 Field Equipment Calibration

Prior to the start of each day's events, field laboratory equipment was calibrated. A Hanna HI 98130 water proof pH, EC/TDS and temperature field probe was calibrated and measurements recorded on daily laboratory calibration maintenance forms, which have been provided. Each day a duplicate EC reading was taken at random wells to ensure the calibration of the meter was holding. The duplicate EC readings were taken from wells I-L, PC-127, PC-110, M-131, PC-60, ARP-5A, HMW-16, M-38, M-97, M-95, M-69, PC-31, I-K, M-31A, M148-A, M-11.

SUMMARY RESULTS

7.1 Groundwater Level Soundings

A summary of water level soundings collected for the interceptor and monitoring wells are presented in Table 1.

Pumping water level in interceptors wells. (Measured in feet from below the top of casing.)

Static water level monitoring wells. (Measured in feet from below the top of casing.)

7.2 Summary of Field Activities

7 .2.1 Interceptor Wells

Thirty (30) interceptor wells were sampled for analytical sets including CL04, Cr, TDS and pH.

7.2.2 Monitoring Wells

One hundred sixty five (165) monitoring wells were sampled for sets that may have included: pH, TDS, CL04, CR and CRVI.

7.2.3 QC Duplicate Samples (Measured for the same analyses as the primary samples.)

9

I-L, PC-132, PC-142, M-44, M-57A, M-35, M-12A and M-144

7.2.4 Equipment Blanks

Seventeen (17) equipment blanks were analyzed for CL04, Total Cr., Hex Cr., pH, and TDS. One equipment Blank was analyzed for CL04 only.

10

Table of Well Gauging Data

森林

This Section Contains:

- Field Sign In Log
- Daily Maintenance & Calibration Log
- Table 1 Well Inventory
- Chain-of-Custody & Bottle Order Forms

 \mathcal{I}

ENVIROGEN QUARTERLY SAMPLING SIGN IN SHEET

 $\ddot{}$

ENVIROGEN QUARTERLY SAMPLING SIGN IN SHEET

 \overline{a}

 \bar{a}

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD DATE 5-4-15

HANNA FIELD PH METER

HANNA FIELD EC METER

 \sim

 \mathcal{L}^{\pm}

 Θ^{∞}

All equipment was rinsed and purged with Deionized water after each well.

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD DATE 5-5-15

 $\bar{\mathbf{v}}$

 $\overline{}$

HANNA FIELD PH METER

HANNA FIELD EC METER

 $\hat{\boldsymbol{\theta}}$

All equipment was rinsed and purged with Deionized water after each well.

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD
DATE 5-6-15

HANNA FIELD PH METER

HANNA FIELD EC METER

All equipment was rinsed and purged with Deionized water after each well.

Date 5-6.5 Verified MB
ENVIROGEN **DAILY MANTENANCE AND CALIBRATION RECORD** <u>DATE 5- 1- ነ5</u>

HANNA FIELD PH METER

HANNA FIELD EC METER

All equipment was rinsed and purged with Deionized water after each well.

Date $W\&$ Verified $W\cdot 7 - 15$

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD
DATE 5-6-15

HANNA FIELD PH METER

HANNA FIELD EC METER

 $\sim 10^7$

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD DATE 5-14-15

HANNA FIELD PH METER

HANNA FIELD EC METER

DAILY MANTENANCE AND CALIBRATION RECORD
DATE 5-19-15 **ENVIROGEN**

HANNA FIELD PH METER

HANNA FIELD EC METER

ģ.

Well # $ARP-5A$ **Duplicate EC reading** 2nd Reading 1st Reading $ECUQ$ TEMP QUU^{oc} $\frac{EC}{MS}$ $\frac{49}{cm}$ TEMP $\frac{24.5}{cm}$ MSICM
CLOSING QC Every 8 samples P RP-6B $ARP-2A$

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD
DATE 5 20-15

HANNA FIELD PH METER

HANNA FIELD EC METER

All equipment was rinsed and purged with Deionized water after each well.

Date $5 - 20 - 15$ Verified $m + 1$

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD DATE 5

HANNA FIELD PH METER

HANNA FIELD EC METER

 f°

 \sim

All equipment was rinsed and purged with Deionized water after each well.

 $Date 521115$ Verified $M6$

DAILY MANTENANCE AND CALIBRATION RECORD DATE <u>'522</u>-15

HANNA FIELD PH METER

HANNA FIELD EC METER

All equipment was rinsed and purged with Deionized water after each well.

Date $\sqrt[3]{2^{15}}$ Verified $-\gamma$ \approx

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD DATE $5 - 26 - 15$

HANNA FIELD PH METER

HANNA FIELD EC METER

Date $5 - 24 - 15$ Verified $M\beta$

DAILY MANTENANCE AND CALIBRATION RECORD DATE<u>S-27-1</u>5

HANNA FIELD PH METER

HANNA FIELD EC METER

Duplicate EC reading Well # MC/\sqrt{Q}

 $Date5-27-15$ verified $-MD$

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD
DATE 5-28-15

HANNA FIELD PH METER

HANNA FIELD EC METER

All equipment was rinsed and purged with Deionized water after each well.

Date 5-28-6 Verified MB

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD
DATE <u>S-29-</u>15

HANNA FIELD PH METER

HANNA FIELD EC METER

2nd Reading TEMP 27.0 ^{oc} **CLOSING QC** Every 8 samples

T-\(~}t *lo95*

 $EC \frac{5.17}{10.05}$ TEMP.

NIŽI

All equipment was rinsed and purged with Deionized water after each well.

 \mathbb{R}^n

Date $5-29-15$ Verified $\sqrt{2}$

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD DATE $\sqrt{\Delta}$ | 5

HANNA FIELD PH METER

HANNA FIELD EC METER

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD ₍₂₀ DATE ^{0'}5 - IS

HANNA FIELD PH METER

HANNA FIELD EC METER

('(\ • \":> **'V l£** . gq

EC 5.43 TEMP 28.7

Duplicate EC reading Well $\frac{\mathbf{M} \cdot \mathbf{M} \cdot \mathbf{A}}{\mathbf{M} \cdot \mathbf{A}}$

1st Reading 2nd Reading $CLOSING'QC$ Every 8 samples $EC \rightarrow 1$ TEMP $\sqrt{\ }$ km \sim 24 O

Date $12.3 - 15$ Verified MD

ENVIROGEN DAILY MANTENANCE AND CALIBRATION RECORD أولا أوراد DATE $6-5-15$

HANNA FIELD PH METER

HANNA FIELD EC METER

ENVIROGEN

DAILY MANTENANCE AND CALIBRATION RECORD
DATE_7 - 14 - 15

Ï

HANNA FIELD PH METER

HANNA FIELD EC METER

 $Well# PCL-122$ **Duplicate EC reading** 2nd Reading 1st Reading TEMP 33.5° 8 TEMP 33. EC 2.49 ECQ^1 **CLOSING** Every 8 samples
 LCB σ_{M} β $PC-100$ 7.01

Date 1-14-15 Verified MB

TABLE 1 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada

Summary of Field Data for: 2nd Ouarter Groundwater Monitoring, May 2015

alaire Muchelle Brown

TABLE 1 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada Summary of Field Data for: 2nd Quarter Groundwater Monitoring, May 2015

Sampling Crew Signature: Muchelle Brown

TABLE 1 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada Summary of Field Data for: 2nd Quarter Groundwater Monitoring, May 2015

Sampling Crew Signature: *Meabel Brown*

TABLE 1 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada

Summary of Field Data for: 2nd Quarter Groundwater Monitoring, May 2015

Sampling Crew Signature: *Muchele Brown*

f

TABLE 1 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada Summary of Field Data for: 2nd Quarter Groundwater Monitoring, Mav 2015

Sampling Crew Signature: *Michele Brown*

TABLE 1 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada Summary of Field Data for: 2nd Quarter Groundwater Monitoring, May 2015

NON-TOP OF
CASING GROUNDWATER **SPECIFIC** WELL $\#$ DEPTH $\left|\begin{array}{cc}\text{CASING} & \text{DEFIN~IO}\ \text{DEPTH} & \text{WATER} & \text{PHASE} \end{array}\right|$ ELEVATION PHASE ELEVATION (FT MSL) MONITORING COMMENTS/Analytical Plan/Temp pH CONDUCTIVITY DATE TIME (mS/cm) DTW Only 28.00 **1742.29 20.75 1721.54** 1721.54 1721.54 5/22/2015 5 $M-174$ 28.00 1742.29 DTW Only 29.00 1742.74 21.56 1721.18 5122/2015 1 6:42 M-175 ------- . "------ --------- 30.00 1745.35 24.22 1721.13 5/22/2015 ! 6:40 DTW Only M-176 ---.. ·-~---. - -• 30.00 1743.23 21.73 1721.50 1721.50 30.00 5/22/2015 6:38 DTW Only M-177 -. -- -------------- + - ---- ----- pH, TDS, Cr, ClO₄ 50 1614.96 27.73 1587.23 7.22 10.81 5/19/2015 12:16 MW-K4 ---------- pH / TDS / Cr / Cl04 / NO3 / CLO3 1598.87 30.12 **1568.75** 7.15 9.33 5/19/2015 10:50 44 MW-K5 pH, TDS, Cr, CIO₄ 52.11 $\begin{array}{|c|c|c|c|c|c|c|c|c|} \hline \end{array}$ 1618.39 28.28 1590.11 1590.11 7.12 12.56 5/27/2015 7:53 $PC-18$ 32.86 | 1595.17 | 27.42 | 1567.75 | 7.34 | 5.88 | $5/19/2015$ | 10.34 pH, TDS, Cr, CIO₄ **PC-53** 1595.17 27.42 8.87 5127/2015 I 6:25 pH, TDS, Cr, CIO4 7.32 **PC-55** 549 1618.46 27.44 1591.02 ---···- -------- 7.48 6.35 5/14/2015 ! 11:44 pH, TDS, Cr, CIO₄ $PC-56$ $\begin{array}{|c|c|c|c|c|c|c|c|}\n\hline\n\text{63.58} & \text{1576.83} & \text{21.21} & & & \text{1555.62} \\
\hline\n\end{array}$ 7.41 4.75 5/14/2015 11:22 pH, TDS, Cr, CIO₄ $PC-58$ 42.78 1,576.79 21.95 1554.84 7.49 3.53 5114/2015 ! 12:45 pH , TDS, Cr, CIO₄ $PC-59$ 48.13 1576.05 19.71 1556.34 $pH, TDS, Cr, ClO₄$ 48.09 1576.47 20.41 1 1556.06 7.65 3.01 5/14/2015 12:20 PC-60 1576.47 2.59 5/19/2015 pH, TDS, Cr, CIO₃ 7.43 $8:31$ **PC-62** 45.91 1575.74 18.87 1556.87 \vert pH, TDS, Cr, ClO₄ 64.72 I 1576.39 18.83 1557.56 8:58 PC-68 pH / TDS / Cr / Cl04 / NO3 / CLO3 35.75 I 1561.60 12.11 1549.49 9:30 PC-86 \cdots \cdots \cdots 7.56 3.96 5/14/2015 10:02 pH / TDS / Cr / Cl04 / NO3 / CLO3 **PC-90** 15.0 1550.46 | 5.67 | 1544.79 7.60 3.93 5/14/2015 10:22 **pH** / TDS / Cr / Cl04 / NO3 / CLO3 $\begin{tabular}{|l|c|c|c|c|c|c|c|} \hline PCC-91 & 37.0 & 1552.33 & 11.08 & 1541.25 \\ \hline \end{tabular} \begin{tabular}{|c|c|c|c|c|c|} \hline PAC & 1541.25 & 1541.25 \\ \hline \end{tabular}$ 37.0 1552.33 11.08

TABLE 1 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada Summary of Field Data for: 2nd Quarter Groundwater Monitoring, May 2015

Sampling Crew Signature: Muchele Diouh

TABLE 1 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada

Summary of Field Data for: 2nd Quarter Groundwater Monitoring, May 2015

TABLE l Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada

Summary of Field Data for: 2nd Quarter Groundwater Monitoring, May 2015

TABLE 1 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada Summary of Field Data for: 2nd Quarter Groundwater Monitoring, May 2015

TABLE 1 Well Inventory for Groundwater Sampling NERT Project, Henderson, Nevada

Summary of Field Data for: 2nd Quarter Groundwater Monitoring, May 2015

NOTES:

Monthly 1st Monday Monthly: ARP and PC

Sampling Crew Signature: Mechael Brawn

 $Signature$) is the Syncure Print <u>Nichele</u> Bruer

 $Signature \sim \frac{1}{\sqrt{11}}$ Print Michele Brown

Signature $N\mu\mu\mu$ $SignatureMULALLE BQUA$
Print <u>Nichele</u> Baun

signature M Jeolio Braus

signature <u>Michele</u> Broun

 $\frac{N\chi_{\ell}(\mathcal{L})}{\chi_{\ell}(\mathcal{L})}$ shown Print M ichele 5000

17461 Derian Ave
Suite 100

 \ddotsc

 α

 $\mathcal{L}_{\mathcal{A}}$

ISSIAT ISTICO

 \sim

17461 Derian Ave

Sune 100

Irvine, CA 92614

 \sim

Contract

17461 Derian Ave

Suite 100 Irvine, CA 92614

phone 949.261.1022 fax 949.260.3299

Chain of Custody Record

 $\mathcal{L}_{\mathcal{A}}$

17461 Denan Ave

TestAmerica

Irvine 17461 Derian Ave Suite 100 Irvine, CA 92614 nhone 949 261 1022 fax 949 260 3299

Chain of Custody Record

 \sim

Irvine 17461 Denan Ave Suite 100 Irvine, CA 92614

Chain of Custody Record

 $\sim 10^7$

17461 Derian Ave

Irvine, CA 92614
phone 949.261 1022 fax 949 260.3299

 \mathcal{A}

 $\ddot{}$

17461 Derian Ave Suite 100 Trvine, CA 92614

17461 Derian Ave

Suite 100 Irvine, CA 92614

phone 949.261.1022 fax 949.260.3299

17461 Derian Ave

Suite 100 Irvine, CA 92614
phone 949.261.1022 fax 949.260.3299

17461 Derian Ave Suite 100

Irvine, CA 92614
phone 949.261.1022 fax 949.260.3299

17461 Detian Ave Suite 100

702-371-9307

 P O # 3693

 $\boxed{\times}$ Non-Hazard

}olinguished by

Relinquished by

Relinquished by:

いっぴ

FAX:

phone 949 261 1022 fax 949.260.3299

estAmenc

TestAmerica Laboratories, Inc.

America Testy

y Record

lrvine

FAX⁻

17461 Detroit Ave State 100 hyme, CA 92614

phone 949-261-1022, (as 949-260.3299

Chain of Custody Record

TestAmerica Laboratories, Inc. **Client Contact** Project Manager: Wendy Prescott D ate: $5 - \sqrt{7} - \sqrt{5}$ Site Contact: Wendy Prescott $\overline{\text{Coc.wc}}$ $\sqrt{2}$ Envirogen Technologies Tel/Fax: 702-371-9307 Lah Contact: Patty Mata Carrier: $\begin{tabular}{|l|l|} \hline \hline \hline ph, TDS, CRVI, VOS 150.1, 3540C (2480) \\ \hline 218.6 ORGPU, 360 ORGPW, 1800 CFAU, 1900 ORGFWV, 1801, 12540C (2480). \hline \hline \end{tabular}$ 510 South Fourth Street Analysis Turnaround Time Job No $\begin{cases} CR \ 200.7 - 200.7 \\ \text{pH. TDS. CRVL 1.50.1, 25.40C (210d, 218.6 ORCFyl) \end{cases}$ **Louiser** Henderson, NV 89015 Calendar (C.) or Work Days (W) WORK 702-371-9307 TA1 d'afferent from Below $\lfloor x \rfloor$ pH, TDS 150.1.2540C Calcd SDG No 2 weeks 4 Project Name Envirogen \Box **Tweek** Site NERT- 510 S. Fourth St., Hnederson, NV 89015 \Box \boxtimes $(2,03,300,18,28)$ $2~\rm{days}$ $PQ43693$ \Box 4 day CLO4314.0 المارام.
التقييد Samole Samole Sample \mathcal{U} af Date Time $_{\rm Coul}$ Sample Identification Γ pc **Matrix** T.R - 8 47 164 \times 5-14-15 ्द 0709 ⋊ NORMAL WATER $M - 120$ $5 - 15.15$ ζ 1151 NORMAL WATER $M - 118$ $5 - 19 - 51300$ ス ええひ NORMAL WATER $M - 121$ lx. $5.19 - 5.1348$ \mathbb{C} χ χ NORMAL WATER NORMALI WATER NORMAL WATER NORMAL WATER NORMAL WATER NORMAL WATER normal ¦ WATER NORMAL WATER NORMAL WATER $||\cdot||$ Preservation Used: 1+ ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other Sample Disposal (A fee may be assessed if samples are retained longer than 1 month) Possible Hazard Identification \Box Non-Hazard \Box Flammable \Box Non-friend Poison B \Box Unknown $\cancel{\varphi}$ Disposal By Cab return To Client Archive For **Ymonths** I attest to the validity and authenticity of this (these) sample(s). I am aware that tampering with or intentionally mislabeling the sample(s) location, date or time of collection may be considered fraud and subject to legal action (SolC445:0636) $_{\text{Date}}$ 5 - 19 - 15 Signature: يتعب ' La ... Special Instructions/QC Requirements & Comments NEEDS LEVEL 4 REPORT $\frac{\text{Date'Time}}{6^{2}/10^{2}/10^{2}}$ /0/3 Relinquished by Company: Dato/Time Received by Company⁻ ed Wadel Relinquished by Strumpt EN, تەيرادىسى ئەستا $-\tau z$ Date/Time Company. Date/Time/ Received by Company: Relinquished by: Company Date/Time: Received by Date/Time Соникину

17461 Derian Ave Saite 100

Irvine, CA 92634
where 0.0.361.1023. For 0.10.260.1300

 $\ddot{}$

 $\frac{1}{2} \left(\frac{1}{2} \right)^2 \left(\frac{1}{2} \right)^2$

 ϵ

 ϵ

17461 Derian Ave Suite 100

Irvine, CA 92614

mhone 949 261 1022. Gy 949 260 3299

17461 Dernar Ave Suite 160 fryine, CA 92614

uhone 949-261-1022, fax 949-266-3299.

FestAmerica Laboratories, Inc. **Client Contact** Project Manager: Wendy Prescott Site Contact: Wendy Presenti Date: **COC No** Envirogen Technologies Tel/Fax: 702-371-9307 Lab Contact: Patty Matu Carrier $\begin{bmatrix} \mathsf{ph}, \text{TDS}, \text{CRY1}, \text{NO3 1 S01}, \text{2540C} \\ \text{318.6 } \text{ORCF11}, \text{500 } \text{ORCF1X3} \\ \text{ph}, \text{TDS}, \text{NO3 } \text{1 S01}, \text{15540C} \\ \text{J00 } \text{ORCF1X} \end{bmatrix}$ 510 South Fourth Street Analysis Turnaround Time Job No Henderson, NV 89015 Calendar (C.) or Work Days (W) WORK p11, TDS, CRVE, E80, E2540C Caled,
218.6 ORGEN 702-37: -9307 3 M a different from Betow 取上 $506N_o$ p18, TDS 150.1 2540C Cated leax. 2 weeks Project Name: Envirogen Γ i **Lweek** Site NERT-510 S. Fourth St., Hinederson, NV 89015 L_{α} 2 days. $\frac{2}{3}$ P Q $#$ 3693 C R 200.7 - 200.7 Γ ⁻¹ 1 day 2LO3 300.1B 21304314.0 Mered Sample. Sample Sample. μ of Sample Identification Cant. Date. Time Type: Matrix $TR-2$ SDHS 1330 NORMAL WATER \sim \mathbf{X} lx١ Ų. $TR-11$ $\overline{\chi}$ \vert \times $\overline{\mathcal{K}}$ 5-21-15 | 940 今 NORMAL¹ **WATER** $TR-12$ $\overline{\varkappa}$ $\overline{\chi}$ \times 5 21-15 | 1138 \mathcal{Z} NORMAL WATER $M - 152$ $\overline{\mathsf{x}}$ $\overline{\chi}$ $|5245|750$ \mathcal{Z} χ I normal.) water \times \ltimes $M-156$ \times $5 - 31 - 6$ 8.57 \mathcal{L} NORMAL WATER E. Blank $\tilde{\mathbb{Z}}$ \vee \mathbf{y} $5 - 21 - 15$ 1800 × NORMAL WATER NORMAL WATER NORMAL WATER NORMAL WATER NORMAL WATER normal] water NORMAL WATER Preservation Used: 1= Ice, 2= HCl; 3= IDSO4; 4=HNO3; 5=NaOH; 6= Other Sample Disposal (A fee may be assessed if samples are retained longer than 1 month) Possible Hazard Identification Non-Hazard C Hommuthe Skin britain Poison B C Unknown C Unknown C Neutral To Client Disposal By Tab Archive For Archive For **Proboths** subject to legg setten (NAC1153636) $p_{\text{ate}} \leq -2.1 - 15$ سيجيسس $Siennurc$. Special Instructions/QC Requirements & Comments: NEEDS LEVEL 4 REPORT Date/Time $\frac{1}{\sqrt{2\pi}}$ Relinquished by Date/Tune Received by: Company Relinquisted by Hall Hall Company 142 ks off Strugart -21-157 $|z\rangle$ أسألأ فلتر Date/Time Date/Time, Received by: .
.ombany Company Relinquished by: Date Time. Received by Date/Time Company Company

ISTAINEN

Irvine 17461 Derian Ave

╱

Suite 100

Irvine, CA 92614 أنمات

COUNTRYCO

17461 Derian Ave Suite 100 Irvine, CA 92614

17461 Detain Ave Suite 100

Irvine, CA 926H

phone 949 261 1022 1av 949 260 3299

 $\overline{\mathcal{L}}$

17461 Derian Ave Suite 100

Irvine, CA 92614

TestAmerica

Chain of Custody Record

 \bar{t}

irvine

 $\mathcal V$

17461 Derian Ave

 \mathcal{V}

17461 Derian Ave

irvine, CA 92614

17461 Derian Ave Suite 100

 $\overline{\mathcal{L}}$

Irvine, CA 92614
phone 949.261 1022 fax 949 260 3299

Chain of Custody Record

 \sim

17461 Derian Ave

Irvine, CA 92614

phone 949.261.1022 fax 949.260.3299

 $\mathcal V$

17461 Derian Ave Suite 100 Irvine, CA 92614
phone 949 261 1022 fax 949 260 3299

Chain of Custody Record

 $\frac{1}{2}$

Irvine 17461 Derian Ave Suite 100

 $\mathcal V$

Irvine, CA 92614

Irvine 17461 Derian Ave

Suite 100

 $\check{}$

سن

Irvine, CA 92614

17461 Derian Ave Suite 100

Irvine, CA 92614
phone 949.261.1022 fax 949.260.3299

17461 Derian Ave Suite 100 Irvine, CA 92614 ahona 840.241.1022. 6v 040.260.2200.

 31 Y 233 C 17461 Derian Ave Suite 100

 $\overline{\mathscr{S}}$

Irvine, CA 92614
phone 949 261 1022 fax 949 260.3299

17461 Derian Ave Suite 100 Irvine, CA 92614

photo: 949.261.1022. 6s: 949.260.3200

Chain of Custody Record

The American State Automotive Approaches

trvine

17461 Derian Ave

Itvine, CA 92614 phone 949.261.1022 fax 949.260.3299

Bottle Order Information
Bottle Order: NER

NERT - Quarterly 2nd RCRA Wells Bottle Order #: 4309 Filled by: Request From Client: 1/2/2015 Sent Date: Date Order Posted: 312212013 2:43:14PM Sent Via: Order Status: In Process Tracking#: Prepared By: Sushmitha Reddy Deliver By Date: 4/20/2015 11:59:00PM

Lab Project Number: 44008228

Order Completion Information

Creator: Sushmitha Reddy

Notes to Field Staff: **high-state of the Safety Alberta Control** Health and Safety Notes:

Please notify us immediately if an error is found in shipment

Bottle Order Information

Bottle Order: NERT - Quarterly 2nd Wells 4310 Bottle Order #: Request From Client: 1/2/2015 Date Order Posted: 3/22/2013 2:49:32PM **Order Status:** Shipped Prepared By: Sushmitha Reddy Deliver By Date: 4/20/2015 11:59:00PM Lab Project Number: 44008228

Order Completion Information

Creator: Sushmitha Reddy Filled by: Process Server (DO NOT DELETE) Sent Date: 4/21/2015 12:00:00AM Sent Via: FedEx Ground Tracking #: 312947730112264, 312947730112271, 312947730112288, 312947730112295, 312947730112301, 312947730112318,

Please notify us immediately if an error is found in shipment

Notes to Field Staff:

Preservative :·c-;:c.''' _,_

Comment

Ethylene Diamine

'i<

CAUTION! CORROSIVE! CONTAINS ETYLENEDIAMINE. Harmful if inhaled. Use adequate ventilation. Harmful in contact with skin and eyes. If contact is made, FLUSH IMMEDIATELY with water.

-· --- .,. *•:o••c-..* ---- •-• :--·--•-< < .'.> ;c __ .--c;-_-_-;;--c_

Bottle Order Information

Bottle Order: NERT - Quarterly M-10 Bottle Order #: 4296 Request From Client: 1/2/2015 Date Order Posted: 3/21/2013 12:00:12PM Order Status: Shipped Prepared By. Sushmitha Reddy Deliver By Date: 6/29/2015 11:59:00PM Lab Project Number: 44008210

Order Completion Information

Sushmitha Reddy Creator: Filled by: Process Server (DO NOT DELETE) Sent Date: 6/29/2015 12:00:00AM Sent Via: FedEx Ground Tracking #: 312947730117429

Notes to Field Staff:

Health and Safety Notes:

ENVIRO TECHNOLOGIES

Groundwater Field Log

This Section Contains:

• Water Sampling Field Logs

 \sim

 $\frac{\partial \theta_{\alpha}^{(i)}(\theta_{\alpha}^{(i)})}{\partial \theta_{\alpha}^{(i)}(\theta_{\alpha}^{(i)})}$

 \mathbf{r}

 $\hat{\vec{r}}$

-omments: screen 14.39

Comments:

 \sim κ .

 \sim

 $\frac{1}{2}$

 $\mathcal{A}^{\mathcal{A}}$

DTW ONLY

TOTAL Bottles- $\overline{\smash{\bigcup}}$

Water Sampling Field Log Well No.: \angle RT-7 Site: NERT PROJECT- HENDERSON, NEVADA Project No.: The contract of t Sampling Team: Michele Brown Date: Electric pump O Sampling Method: Sample Port O Disposable Bailer O **Weather Conditions:** Well Information: 389 Total Well Depth: feet $Time:$ Purge Depth to Water: feet Well Diameter (circle one) Volume $7 - \overline{1}$ $6 - in$ $2 - in.$ 0.4893 1.9 441 x Water Column (L): feet **Field Measurements:** Depth Purging From: 2 ft below DTW **Observations Time** Temp qals pH of Sample Well capped
Not able to collect data **Comments:** Sample Collection Time pH / TDS/ CRVI pH/TDS/NO3 pH / TDS / CRVI / NO3 Analyses: CR CLO4 pH /TDS Bottles: 1 Bottle 1 Bottle 1 Bottle 1 Bottle 1 Bottle 1Bottle **TOTAL Bottles-**

TOTAL Bottles- *3*

 $\bar{\beta}$

Well No.: A - R T- G Project No.: Site: NERT PROJECT- HENDERSON, NEVADA $5 - 4 - 15$ Sampling Team: Michele Brown Date: Date: Date: Sampling Method: Sample Port ¹ Disposable Bailer O Electric pump O Cloud \mathbf{A} Weather Conditions: Arni \mathbf{u} \mathcal{N} Λ AM **Well Information:** $5.28 - 15$ 43.0 Total Well Depth: Time: LOOT feet ි(ふり Depth to Water: feet **Purge Volume** Well Diameter (circle one)
2-in. 4-in. 6-in. $4\overline{m}$. 1265 Water Column (L): f eet X 0.4893 1.9 4.41 =

Field Measurements: Depth Purging From: 2 ft below DTW

Comments:

 $\ddot{}$

Water Sampling Field Log

comments: Top of screen 25'

OLin Field

 \sim \sim

Water Sampling Field Log

TOTAL BOTTLES-8

comments: Top of screen.?

 $\mathcal{A}^{\mathcal{A}}$

TOTAL BOTTLES: 2

Well No.: HMW-13

 \sim

 $\sim 10^{-1}$
Well No.: θ $\Lambda \Omega$ = θ

Comments:

 $\overline{}$

 $\sim 10^{-11}$

Water Campuling Field L

Field Measurements:

 $\sim 30\%$

Field Measurements:

Project No.:

 $\mathcal{L}^{\mathbb{R}^{n\times n}}$

Contract Contract

 \mathbb{R}^2

Comments:

Time

OOK

Closing OC 699

Field Measurements:

Field Measurements:

Field Measurements:

Depth to

 \mathcal{A}

 \sim

Analyses: pH / TDS CR CLO4
Bottles: 3 Bottles

3 Bottles

Well No.: I - $\overline{\mathsf{I}}$

 $\sim 10^{-1}$

Comments:

 ~ 100

 $X \rightarrow K$

Water Sampling Field Log

Comments:

DUPEC $\frac{7.13}{50}$ 3 $\frac{250^{\circ}}{100}$

 $\mathcal{L}^{\text{max}}_{\text{max}}$ and $\mathcal{L}^{\text{max}}_{\text{max}}$

 $\frac{1}{2}$

Field Measurements:

Comments:

3 Bottles

 $\overline{}$

 $\label{eq:2.1} \frac{1}{\sqrt{2}}\int_{0}^{\infty}\frac{1}{\sqrt{2\pi}}\left(\frac{1}{\sqrt{2\pi}}\right)^{2\alpha} \frac{1}{\sqrt{2\pi}}\int_{0}^{\infty}\frac{1}{\sqrt{2\pi}}\left(\frac{1}{\sqrt{2\pi}}\right)^{\alpha} \frac{1}{\sqrt{2\pi}}\frac{1}{\sqrt{2\pi}}\int_{0}^{\infty}\frac{1}{\sqrt{2\pi}}\frac{1}{\sqrt{2\pi}}\frac{1}{\sqrt{2\pi}}\frac{1}{\sqrt{2\pi}}\frac{1}{\sqrt{2\pi}}\frac{1}{\sqrt{2\pi}}$

Closing Qc pH 1.01

 $\sim 10^6$

Comments:

 $\sim 10^{-10}$

Field Measurements:

closing Qc 100

Field Measurements:

 ~ 10

Comments:

 $\mathcal{L}(\mathbf{z})$ and $\mathcal{L}(\mathbf{z})$

Field Measurements:

Depth to

 $\ddot{}$

l.

Bottles: 3 Bottles

Analyses: pH / TDS CR CLO4

 \sim

Field Measurements:

TOTAL BOTTLES:

TOTAL BOTTLES $\overline{\mathscr{L}}$

 \sim

~omments:

Comments: \0~ *0.,1;* ~e_re_e_V) • .":lq *¹*

TOTAL BOTTLES- 8

comments: Top of screen-?

<u>TOTAL BOTTLES-8</u>

comments: Top of screen-?

Training Center

North Unit 4

 $\mathcal{L}^{\text{max}}_{\text{max}}$

Comments:

TOP OP Sereen-14.5

TOTAL BOTTLES: _______

..;omments:

Dresel tank

comments: Top of Screen-16

TOTAL BOTTLES: VO

Comments:

k,

Comments:

hand bailed due to Location

Water Sampling Field Log $M - 33$ Well No.: Site: NERT PROJECT- HENDERSON, NEVADA Project No.: 71415 Sampling Team: Michele Brown, Date: Sampling Method: Electric Pump O Dedicated Bailer O Non Dedicated Bailer O Ready Flo 2" O \triangle **Weather Conditions:** Measured **Well Information:** $Time: 0100$ Total Well Depth: feet Well Depth to Water: feet Well Diameter (circle one) Volume (WV) $2\overline{m}$ $\overline{4}$ -in. 7.31 16 gal. $*$ Height of Water Column (L) $\times 3$ 0.16 gal/ft feet/ \star [∕].65 gal/ft * 1.47 gal/ft **Field Measurements:** Depth Purging From: 2 ft. below depth to water Cumulative Volume **Specific Time** Purged Conductivity **Observations** pH Temp Nolo 0613 **FiAle mestam** .22 qal β molen 5.38 D616 .27 gal 25.8° 5.27 ms/cm 0699 ್ರನಿ gal Sample Appearance: Time Start: 00020 $O(620$ Time Finished: Sample Collection-**H/TDS** ΈR Analyses: CLO₄ pH / TDS / CRVI pH / TDS / CRVI / NO3 pH / TDS / NO3 CLO₃ Bottles: $1 BTL$ $1 BTL$ $1 BTL$ $1 BTL$ $1 BTL$ $1 BTL$ $1 BTL$ Z **TOTAL BOTTLES:** hand bailed due to location Comments:

 \sim

Comments:

 ~ 10

3362277

i
S

Comments:

 $\hat{\mathcal{A}}$

comments: Top of sereen - 12.7

 $\hat{\mathcal{L}}$

 $\hat{\mathcal{L}}$

 $\hat{\mathbf{v}}$ $\hat{\mathbf{v}}$,

 $\mathbf{\hat{j}}$

 \sim

comments: Top of screen - 15.3

 $\frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}$

 $Comments: Top of screen - 17.5$

 $\mathcal{L}^{\text{max}}_{\text{max}}$. The set of $\mathcal{L}^{\text{max}}_{\text{max}}$

 $Comments: Top of screen - 1D.$

 $\sim 10^{-1}$

 $\mathcal{L}^{\text{max}}_{\text{max}}$

 $\mathcal{F}_{\mathcal{C}}$

Λ.

Comments:

Comments:

 $\label{eq:2.1} \frac{1}{\sqrt{2}}\left(\frac{1}{\sqrt{2}}\right)^{2} \left(\frac{1}{\sqrt{2}}\right)^{2} \left(\$

 $\mathcal{L}^{\text{max}}_{\text{max}}$. The $\mathcal{L}^{\text{max}}_{\text{max}}$

k,

 $\hat{\mathcal{L}}$

 $Botties:$ $(1 BTL)$ $1 BTL$ $(1 BTL)$ $(1 BTL)$

 $\beta_{\rm{ex}}$

TOTAL BOTTLES $\overset{3}{\leq}$

 \mathbb{Z}^2

 \mathbf{A}

Comments: $S厌EN$ $10.8 - 40.3$

CLOX

Comments:

Water Sampling Field Log N-a3 Well No.: Project No.: Site: NERT PROJECT- HENDERSON, NEVADA $5:38-15$ Sampling Team: Michele Brown, Date: Electric Pump O Dedicated Bailer O Non Dedicated Bailer O Sampling Method: Ready Flo 2" 0 $\Omega \Omega$ Weather Conditions: **Well Information:** $Time: \ \Omega \cup \mathcal{B}$ Total Well Depth: j~ o<J feet Depth to Water: feet Well $\frac{\text{Well Diameter (circle one)}}{\text{2-in.}}$ Volume (VVV) Height of Water Column (L): \ :!J . **'7** 't. • 0.65 gallft • 1.47 gal/ft = __ --".::::.:.. gal. * x 3 **Field Measurements:** Depth Purging From: 2 ft. below depth to water **Cumulative Volume Specific Conductivity Temp Observations Time Purged pH** ____ -----""ga:::..l _______ _ ____ -----"'ga:::..l _______ _ ____ ---~g~a~l ___ _ ____ _ \mathcal{U} $\mathcal{U} \Omega$ Sample Appearance: Time Finished: _______ Sample Collection - Time Start: Analyses: CLO4 pH / TDS CR pH / TDS / CRVI pH / TDS / CRVI / NO3 pH / TDS / NO3 CL03 Bottles: 1 BTL 1 BTL 1 BTL 1 BTL 1 BTL 1 BTL $1 BTL$

Comments:

 $\mathcal{L}^{\text{max}}_{\text{max}}$, $\mathcal{L}^{\text{max}}_{\text{max}}$

Total Water Volume Purged:

Comments: Could not sample nell DUE to water level in Casing being lones than Topot Pump

Depth to Water:

Time

ELL PURGING AND SAMPLING LOG

Total Water Volume Purged: 1800 241 Comments: **Comments:**

Τ

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Sample Collection Date: S-19-19 Sample Collection Time: 13:00

Sampling Equipment: Ded reated purp

Total Water Volume Purged: 200 44/

Comments:

Collection Date: $6 - 19 - 15$ Collection Time: $11:5/$ Equipment: *Dedicated pump*

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG $\sqrt{2}$

 \hat{u} .

Total Water Volume Purged: 2 700 ML

Ĵ

Comments:

outside Fence south Ap LAB

comments: Top of screen - 36/

old salt house

outside tence south AP Change house

 \sim \sim

 \mathcal{T}

 \sim

Well No.: <u>M-132</u>

 $\sim 10^{-1}$

NORTH IK

 $\frac{1}{2}$

Comments:
• Water Sampling Field Log Well No.: $M-136$ Project No.: Site: NERT PROJECT- HENDERSON, NEVADA ら Q . Sampling Team: Michele Brown, Date: Sampling Method: Electric Pump @ Dedicated Bailer O Non Dedicated Bailer O Ready Flo 2" O ∞ Weather Conditions: Well Information: Total Well Depth: $\mathbb{Q} \cup \mathbb{O}$ feet Time: $\mathbb{Q} \setminus \mathbb{S}$ Depth to Water: \mathbb{R} , \mathbb{R} feet \mathbb{R} feet Well $\frac{1}{\sqrt{2} \cdot \ln \frac{1}{\ln \frac{1}{1}} \cdot \ln \frac{1}{1}}$ (Volume (WV) Height of Water Column (L): 59.89 feet $\sqrt{2 \cdot \ln x}$ $4 \cdot \ln x$ 6- $\ln x$ 6- $\ln x$ = 9.56 gal. * x 3 $4 \cdot n$ α Field Measurements: **Depth Purging From: 2 ft. below depth to water** Cumulative Volume Specific Time Purged pH Conductivity Temp Observations 0.930 10 gal 4.89 also mskm 23.8 or eller $\overline{\mathcal{C}}$ 0938 ∂O $\ddot{\mathbf{t}}$ gal \bar{z} $\mathsf{f}\mathsf{S}$ A^q q gal Dear Sample Appearance: Time Finished: $\rm \sim$ 0949 Time Start: 0949 Sample Collection pH / TDS / CRVI Analyses: .O4 TD: ĆR pH / TDS / CRVI / NO3 pH / TDS / NO3 CL03 Bottles: **BT** BT 1 BTL 1 BTL 1 BTL 1 BTL 1 BTL RТ TOTAL BOTTLES \Box Comments: \top Op of \angle CICEA - Υ 19.7'

Ind supply

Indus. Supply

Ļ,

 \bar{z}

ł, $\ddot{}$

 $\frac{1}{3}$

 \sim

STEWART ENVIRONMENTAL, INC.

Sample Collection Date: 5-20-15 Sample Collection Time: 6:50

Sampling Equipment: Dedicated pump

Total Water Volume Purged: 2, 400 ML

Comments: And Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Sample Collection Date: 5-20-19 Sample Collection Time: 13.55

Sampling Equipment: Dedscorted power

Total Water Volume Purged: 2 400 24 /

Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Sample Collection Date: $5 - 36 - 15$ Sample Collection Time: 12:43 Sampling Equipment: Dedicated punp

Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG Project Number: $13 - 516$. Well Number: $M - 152$ Sampler's Name: Bry Bq Purging Equipment: Dedicated micros pringe pump PVC Casing Type: Z^{γ} Casing Diameter: Inches 145.0 Feet Depth to Well Bottom: *27.28* Feet Depth to Water: 135 Feet Pump Intake Depth: 45 **PSI** Pump Setting: $125 - 145$ Feet Screened Interval: GED/POIL Pump / Tubing Type: Equipment Cleaning Method: Alconal LRInge Emargen holding Pond Purge Water Disposal: 755 Feet Actual Sample Depth:

Sample Collection Date: ら -2/- /ら Sample Collection Time: 7:50

Sampling Equipment: Dedicated permis

Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Total Water Volume Purged: 2/100 201

Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Total Water Volume Purged: 2, 700 AL /

Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Sample Collection Date: 5-26-15

Sample Collection Time: / 3 3 3

Sampling Equipment: COLD MICOU PUSE PUSAR

Total Water Volume Purged: 2, 700 24/

Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Sample Collection Date: 5 - 21 - 15 Sample Collection Time: <u>___________________________________</u> Sampling Equipment: *Dedicated pering*

Total Water Volume Purged: 1800 UL/

Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG \mathbf{r}

Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Sample Collection Date: $6-90-75$ Sample Collection Time: 9:00
Sampling Equipment: Ded.costed pump.

Total Water Volume Purged: 2, 400 AU /

Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Sample Collection Date: S-20-15 Sample Collection Time: 11:00 Sampling Equipment: Ded.cated pump

I

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Comments.

ELL PURGING AND SAMPLING LOG

Total Water Volume Purged: $\sqrt{2\pi}$ $\sqrt{2\pi}$ 22 /

 $\bigg)$

Comments:

 $\label{eq:2.1} \frac{1}{\sqrt{2\pi}}\int_{\mathbb{R}^3}\frac{1}{\sqrt{2\pi}}\int_{\mathbb{R}^3}\frac{1}{\sqrt{2\pi}}\int_{\mathbb{R}^3}\frac{1}{\sqrt{2\pi}}\int_{\mathbb{R}^3}\frac{1}{\sqrt{2\pi}}\int_{\mathbb{R}^3}\frac{1}{\sqrt{2\pi}}\int_{\mathbb{R}^3}\frac{1}{\sqrt{2\pi}}\int_{\mathbb{R}^3}\frac{1}{\sqrt{2\pi}}\int_{\mathbb{R}^3}\frac{1}{\sqrt{2\pi}}\int_{\mathbb{R}^3}\frac{1$

 $\mathcal{L}^{\text{max}}_{\text{max}}$ and $\mathcal{L}^{\text{max}}_{\text{max}}$

 $\label{eq:2.1} \frac{1}{\sqrt{2}}\int_{\mathbb{R}^3} \frac{1}{\sqrt{2}}\left(\frac{1}{\sqrt{2}}\right)^2\left(\frac{1}{\sqrt{2}}\right)^2\left(\frac{1}{\sqrt{2}}\right)^2\left(\frac{1}{\sqrt{2}}\right)^2\left(\frac{1}{\sqrt{2}}\right)^2.$

Comments:

 $\ddot{}$

 $\ddot{}$

 \bar{z}

 \cdot

Comments:

STEWART AWIRONMENTAL, INC.

R WELL PURGING AND SAMPLING LOG

Total Water Volume Purged: 2, 100 201

9101 West Sahara Avenue, Suite 105-B32 -- Las Vegas, Nevada 89117-5772 Telephone: 702/254-6731 - FAX 702/254-6446 Email Address: StewEnvir@aol.com

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Total Water Volume Purged: 2, 700 40/

 $\overline{1}$

Comments: _____

9101 West Sahara Avenue, Suite 105-B32 -- Las Vegas, Nevada 89117-5772 Telephone: 702/254-6731 -- FAX 702/254-6446 Email Address: StewEnvir@aol.com

STEWART ENVIRONMENTAL, INC.

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Sample Collection Date: S-20-15 Sample Collection Time: 10:00 Sampling Equipment: Dedicated porge pour

Comments:

9101 West Sahara Avenue, Suite 105-B32 -- Las Vegas, Nevada 89117-5772 Telephone: 702/254-6731 -- FAX 702/254-6446 Email Address: StewEnvir@aol.com

 $\mathcal{L}^{\text{max}}_{\text{max}}$. The $\mathcal{L}^{\text{max}}_{\text{max}}$

 $\mathcal{L}^{\mathcal{L}}$

 \cdot

Water Sampling Field Log Well No.: $MC-29$ Project No.: Site: NERT PROJECT- HENDERSON, NEVADA 2.1 Sampling Team: Michele Brown, Date: しつ Electric Pump ® Dedicated Bailer 0 Non Dedicated Bailer 0 Ready Flo 2" 0 Sampling Method: Weather Conditions: Well Information: Time: $|110|$ Total Well Depth: 50 feet $3''$ 5 feet Depth to Water: Well Well Diameter (circle one) Volume (WV) 2π $\overline{4}$ -in. $\lvert \mathcal{Q} \rvert \rvert$ gal * x 3 Height of Water Column (L): 1247 10 CM 0.16 gal/ft feel * 0.65 gallft • 1.47 gallft Field Measurements: Depth Purging From: 2 ft. below depth to water Cumulative Volume Specific Time Purged pH Conductivity Temp Observations 113 $\frac{g_{\text{gal}}}{n-1}$ $\frac{7.34}{1.36}$ $\frac{26.78}{1.86}$ $\frac{28.70}{1.86}$ \Im 11.6 gal 7.17 27. Bm m 24. 4 ° Nea <u>IIIZ</u> Lj gal 1.11 St. Smstin 11.3 - 100000
gal 7.09 2684 mfm 27.3 "Regio \Im Ω $r \ell \ell \sim$ Sample Appearance: Time Start: $\sqrt{22}$ Time Start: $\frac{1122}{2}$ Time Finished: $\frac{1122}{2}$
Time Finished: $\frac{1122}{2}$ Sample Collection pH / TDS / CRVI / NO3 pH / TDS / NO3 Analyses: CL03 CLO4 Bottles: 1 BTL 1 BTL 1 BTL 1 BTL 1 BTL 1 BTL COMMENTE LA COMMENTE LA COMMENTE LA COMMENTE LA COMMENTE LA COMMENTE LA COMMENTE COMMENTE COMMENTE SON US A D TOTAL BOTTLES: -2 $\frac{1}{2}$ f_{OU}

comments: TOP Of SCreen - 20

 10^{3} Comments: Top of screen - 31'

Water Sampling Field log $M(1-K)$ Well No.: Project No.: Site: NERT PROJECT- HENDERSON, NEVADA \overline{K} $19 - 15$ Sampling Team: Michele Brown Date: Contact Contact Contact Date: Date: Date: Date: Sampling Method: Electric Pump **@** Dedicated Bailer O Non Dedicated Bailer O Ready Flo 2" O <u>Warm</u> Weather Conditions. Well Information: Time: $\int \! \hat{d} \, \iint \! \mathcal{O}$ Total Well Depth: *5().()* feet Depth to Water: feet Well Purge **Purge** Well Diameter (circle one) Volume (WV) **Factor** Volume $2 - in.$ $\overline{4-\overline{m}}$ A.Tr 2221 feet Height of Water Column (L): 0.65 gal/ft * 1.47 gal/ft = 2 5 $\sqrt{}$ gal. * 3 **≬**0.16 gal/ft Field Measurements: **Depth Purging From: 2ft. below depth to water** Cumulative Volume specific pH Time Purged Conductivity Temp Observations β 2lan
alcan *'1-od* lOlli~ *,Qijnue* O_Q .حـدا ~ 9al 1.35 10.85 msf cm 31.1 oc <u>1.25 10.85 mff in 21.1 oc</u>
1.22 10.81 mfm 266 = λ gal $\mathfrak{Z} \mathfrak{Z}^{\mathsf{r}}$ $Quar$ gal gal gal 9al aleas Sample Appearance: Sample Collection - Time Start: $\sqrt{230}$ Time Finished: $\sqrt{230}$ $Beta$ = $Colection -$
Analyses: $\frac{CLOA}{1~\text{BTL}}$ TDS TOS/pH $\frac{CRA}{1~\text{BTL}}$ (1BTL) (1BTL) (1BTL) (1BTL) Analyses: TOTAL BOTTLES:

comments: Top of screen 9.5'

comments: Top of screen 28.5'

 $PC-1$ Well No.: Project No.: Site: NERT PROJECT- HENDERSON, NEVADA 5-20-15 Sampling Team: Michele Brown, Date: Date: Date: Date: Sampling Method: Electric Pump O Dedicated Bailer O Non Dedicated Bailer O Ready Flo 2" O Q. Ω Weather Conditions: Λ I **Well** Information: Time: 1258 Total Well Depth: \mathcal{X} O feet Depth to Water: **Well** feet Well Diameter (circle one)
 $\frac{2-\ln 4}{1-\ln 4-\ln 6}$ Volume (WV) 2π $\frac{4 \sin \theta}{10.65 \text{ gal/ft}}$ * 1.47 gal/ft = $\frac{1}{2}$ gal, * x 3 feet 0.16 gal/ft Height of Water Column (L): **Field** Measurements: **Depth Purging From: 2ft. below depth to water** Cumulative **Specific** Volume **Observations** Time Purged pH Conductivity Temp 1.11 gal gal gal $T\omega\Omega$ -Sample Appearance: Time Start: Sample Collection - Time Finished: CR. pH / TDS / CRVI pH / TDS / CRVI / NO3 pH / TDS / NO3 ်LO3 Analyses: CLO4 pH / TDS 1 BTL Bottles: \1 BTL 1 BTL $1BT$ 1 BTL 1 BTL 1 BTL **TOTAL BOTTLES:** comments: TOP Of sereen - 14.7'

 $\label{eq:2} \frac{1}{2} \int_{\mathbb{R}^3} \frac{1}{\sqrt{2}} \, \frac$

smments: S_{C} reen $11.5.51.5$

 $\sim 10^{11}$ km $^{-1}$

 \sim

 \cdot omments: SCICEN 13 · 32.5'

comments: Top of sareen. 9.5

 $\sim 10^{11}$ km s $^{-1}$

Water Sampling Field Log PC 55 Well No.: Project No.: Site: NERT PROJECT- HENDERSON, NEVADA $5.27 - 16$ Sampling Team: Michele Brown, Date: Sampling Method: Dedicated Bailer O Electric Pump [●] Non Dedicated Bailer O Ready Flo 2" O **Weather Conditions:** Ω ۱۱ م **Well Information:** Time: 0625 Total Well Depth: reet Depth to Water: feet Well Well Diameter (circle ene) Volume (WV) $2 - in.$ $\overline{4-n}$ ਨਾਨ 121 gal $+0.3($ _{gal.} Height of Water Column (L): 27.46 feet * 0.16 gal/ft * 0.65 gal/ft $x3$ 1.47 gal/ft **Field Measurements:** Depth Purging From: 2 ft. below depth to water Cumulative Volume **Specific** Time Purged **Observations** pH Conductivity Temp 0630 ၈c 7.52 0.655 874 40 ω dal Φ¢ 0719 80 3_C ี865m dal .
6C $|a|$ Ƙ. gal ∩ ∩ θ Sample Appearance: Time Start: 0745 0745 Sample Collection -Time Finished: **CR** Analyses: LO4 (́H / TDS pH / TDS / CRVI pH / TDS / CRVI / NO3 pH / TDS / NO3 CLO₃ Bottles: 1 BTL **BTL** $1 BTL$ $\overline{1}$ BTL $1 BTL$ $1 BTL$

 $screen - 15.3'$

 $\mathcal{O}(\cdot)$

 \bigcirc O

TOTAL BOTTLES

Comments:

Comments: $Sereen - 4.8 - 54.8$

TOTAL BOTTLES: 3
EB-8 collected here
Lefore moumq to mex top
1215 well cr, cloy, cry, pH. TDS

 $-$ omments: Screen $7.8 - 32.8$

 $Comments:$ Screen $+8 - 3 + .8$

Closing QC M.O) Dup EC 22.6" 303
Water Sampling Field log Well No.: $PC-62$ Project No.: Site: NERT PROJECT- HENDERSON, NEVADA $5 - 19 - 15$ Sampling Team: Michele Brown Date: Contract of the Contract of Date: Date: Sampling Method: Electric Pump ³¹ Dedicated Bailer 0 Non Dedicated Bailer 0 Ready Flo 2" 0 Weather Conditions: Well Information: feet Time: \circ \otimes 3 45.9 Total Well Depth. 18.87 Depth to Water: feet Well Purge **Purge Well Qiameter (circle one)**
2-in. (1998–1998) 1999 Volume(VW) **Factor** Volume $2 - in.$ **4-ln. -m** 13 gal Height of Water Column (L): $\partial \eta$. feet 0.16 gal/ft $*$ 0.65 gal/ft $*$ 1.47 gal/ft $=\frac{1}{2}$ $\frac{3}{2}$ $\frac{3}{2}$ Field Measurements: **Depth Purging From: 2ft. below depth to water** Cumulative Volume Specific Time Purged pH Conductivity Temp **Observations** $\frac{00000}{\cdot}$ $\frac{00000}{\cdot}$ o€>~0 1-sw ~·lo~ f!\S'rm a.\·S P. Q *Qo.J.,)* $^{\circ}$ 1.56 a. b 2 n Stm a1.5 oc Qear
743 a. b 4 m Stm a1. 4 clear 5 gal rse orbansphans
743 a. b. 4 mfm ar. 4 clear $\frac{a}{9}$ $\overline{\mathbf{c}}$ <u>OD42 - </u> cal | 2, \cup \vee \vee gal gal gal gal Dear Sample Appearance: Time Start: \bigcirc 849 \qquad Time Finished: 08 Sample Collection - Analyses: ∕DS/pH SLO4 TDS CR Bottles: 1 BTL 1BT **BTI** TOTAL BOTTLES:

Screen 7.6-37.6' omments:

Water Sampling Field log $R7.105$ Well No.: Project No.: Site: NERT PROJECT- HENDERSON, NEVADA $5 - 28 - 15$ Sampling Team: Michele Brown, Date: Date: Date: Date: Sampling Method: Electric Pump ® Dedicated Bailer O Non Dedicated Bailer O Ready Flo 2" O Weather Conditions: 0α Well Information: f eet Time: 101ω $\mathsf{M}.\mathsf{I}\mathsf{O}$ Total Well Depth: -32 feet Depth to Water: **Well** Well Diameter (circle one) **Volume (WV)** $2-\overline{n}$ $4 - \overline{5}$ **A.T** 7.78 $-a\alpha$ Height of Water Column (L): \mathcal{I}_r feet aal. $* x 3$ θ :16 gal/ft * 0.65 gallft * 1.47 gallft Field Measurements: **Depth Purging From: 2ft. below depth to water** Cumulative Volume Specific Time Purged pH **Observations** Conductivity Temp 10% $2^{\circ c}$ 020 Ÿ. gal $\overline{5}$ 1021 $De₁$ ∂S .O dal M' $10a2$ gal Sample Appearance: Time Start: $\{()$ $\}$ $\}$ Time Finished: $[O2]$ Sample Collection - SUT ** Hq **CR** pH / TDS / CRVI pH / TDS / CRVI / NO3 pH / TDS / NO3 CL03 Analyses: CLO₄ 1 BTL Bottles: **BTI** RТ **BTL** 1 BTL 1 BTL 1 BTL 1 BTL TOTAL BOTTLES: rop of screen-4.1'
aloseny QC- 7.02 Comments:

TOTAL BOTTLES: $\overrightarrow{3}$

 $\frac{1}{2}$

Top of screen 6.9 Comments:

Water Sampling Field Log $PC-68$ Well No.: Project No.: Site: NERT PROJECT- HENDERSON, NEVADA 5-19-14 Sampling Team: Michele Brown Date: Sampling Method: Electric Pump @ Dedicated Bailer O Non Dedicated Bailer O Ready Flo 2" O **Weather Conditions: Well Information:** 04.72 feet Time: \bigcirc B5H Total Well Depth: 83 feet Depth to Water: Well Purge Purge Well Dameter (circle one) Volume Volume (WV) Factor $2 - in.$ 4-in. 6-in 45.89 Feet Height of Water Column (L) 0.16 gal/ft * 0.65 gal/ft * 1.47 gal/ft 3 gal. **Field Measurements:** Depth Purging From: 2 ft. below depth to water Cumulative Volume **Specific Time** Purged Conductivity **Observations** рH Temp 090 ėх aai ។ 3 gal எ gal ს M 99 2 Ņ ϱ m dd dal gal gal gal 0 l ea Sample Appearance: Time Start: 0918 Time Finished: $OP1P$ Sample Collection -DS/pH Analyses: LO4 **TDS** ĆR Bottles: $1 BTL$ **BTL** 1BTI **BTI** 1 **TOTAL BOTTLES:** screen 9.9-54.9' Comments:

 $\sim 10^{-1}$

 $\label{eq:2.1} \frac{1}{\left(1-\frac{1}{2}\right)}\left(\frac{1}{\sqrt{2}}\right)^{\frac{1}{2}}\left(\frac{1}{\sqrt{2}}\right)^{\frac{1}{2}}\left(\frac{1}{\sqrt{2}}\right)^{\frac{1}{2}}\left(\frac{1}{\sqrt{2}}\right)^{\frac{1}{2}}\left(\frac{1}{\sqrt{2}}\right)^{\frac{1}{2}}\left(\frac{1}{\sqrt{2}}\right)^{\frac{1}{2}}\left(\frac{1}{\sqrt{2}}\right)^{\frac{1}{2}}\left(\frac{1}{\sqrt{2}}\right)^{\frac{1}{2}}\left(\frac{1}{\sqrt{2}}\right)^{\frac$

 $\mathcal{L}^{\text{max}}_{\text{max}}$

e)
S

 $Scoreen - 26.5 - 36.5$ Comments:

 $\ddot{}$

J

 \mathbb{R}^2

Well No.: PC-94

TOTAL BOTTLES: <u>2</u>

Comments:

 $\Delta_{\rm{th}}$

comments: SCreen 20-35'

<u>or.2</u>" clear

81 C/

 $3Creen 20.50'$ vomments:

 0925

<u>IQ</u>

gal.

<u>gal</u>

<u>7.04 14.93 mskm</u>

 m

gal

....

comments: SCIEEN - 9-29'

AM-DAC

 $\sim 10^{-1}$

Comments:

 ~ 100

 \sim \sim

TOTAL Bottles- 3

 $\sim 10^{-1}$

 $\mathcal{L}^{\text{max}}_{\text{max}}$ and $\mathcal{L}^{\text{max}}_{\text{max}}$

 $\mathcal{L}^{\text{max}}_{\text{max}}$ and $\mathcal{L}^{\text{max}}_{\text{max}}$

Water Sampling Field Log

 ~ 800

 $\mathbf{S}^{(n)}$.

Jmments:

 $\hat{\mathcal{A}}$

 \mathcal{A}

 $\mathcal{A}^{\mathcal{A}}$

 $\mathcal{L}^{(2)}$

 \hat{p} , \hat{p} , \hat{p}

Water Sampling Field Log

 \bar{z}

Water Sampling Field Log

 \sim \sim

Comments: Top of <u>screen</u>. 24.7

 $\label{eq:2.1} \frac{1}{2} \sum_{i=1}^n \frac{1}{2} \sum_{j=1}^n \frac{$

Water Sampling Field Log

 $\sim 10^{11}$

 $2,300 \mu l$ Total Water Volume Purged: Comments: Well MARD PSZ SHOWS - 3.25 PSI

 $1555''/$ km

 1539 $\%$

 $1525^{\circ\circ\circ}/$

15 19 ⁴⁸lex

 $13 - 0$

 1600

 ∂ oco

 2300

 1130

 $1/33$

 1137

 1140

 100

 100

 100

 100

9101 West Sahara Avenue, Suite 105-B32 -- Las Vegas, Nevada 89117-5772 Telephone: 702/254-6731 -- FAX 702/254-6446 Email Address: StewEnvir@aol.com

 $32 - 90$

 33.70

 33.80 0.51 are 7.60 4.85 176.4

 33.30 0.55 are $7.595.22$ 175.5

 0.47 ord 7.60 4.99

 0.4900 765 4.95 1716

 170.8

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Sample Collection Date: 5-21-15 Sample Collection Time: 1330
Sampling Equipment: 02ED pcmp

Total Water Volume Purged: 3,400 UU

Î

Comments: $\frac{1}{2}$

9101 West Sahara Avenue, Suite 105-B32 -- Las Vegas, Nevada 89117-5772 Telephone: 702/254-6731 -- FAX 702/254-6446 Email Address: StewEnvir@aol.com

Total Water Volume Purged: 1,800 UC/ Comments:

 1500

 7500

 130.7

 1310

 100

 $100 -$

9101 West Sahara Avenue, Suite 105-B32 -- Las Vegas, Nevada 89117-5772 Telephone: 702/254-6731 -- FAX 702/254-6446 Email Address: StewEnvir@aol.com

 1276% 236009500801500157031915

Comments:

9101 West Sahara Avenue, Suite 105-B32 -- Las Vegas, Nevada 89117-5772 Telephone: 702/254-6731 -- FAX 702/254-6446 Email Address: StewEnvir@aol.com

Total Water Volume Purged: 2, 100 4x/

Comments:

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Comments:

SAMPLING LOG

on Date: <u>Ŝ - 19 - 1 S</u> on Time: 2:09 ________________

ment: Dediconted pour p

Comments:

STEWART ENVIRONMENTAL, INC.

9101 West Sahara Avenue, Suite 105-B32 -- Las Vegas, Nevada 89117-5772 Telephone: 702/254-6731 - FAX 702/254-6446 Email Address: StewEnvir@aol.com

J ś

j

Ĵ

STEWART ENVIRONMENTAL, INC.

LOW FLOW GROUNDWATER WELL PURGING AND SAMPLING LOG

Total Water Volume Purged: //.5 6-4LUDNS

Sample Collection Date: 5-21-19 Sample Collection Time: 11:38
Sampling Equipment: 960 Permp

Total Water Volume Purged: 3,600 041

Ϊ

Comments:

Annual Remedial Performance Report for Chromium and Perchlorate Nevada Environmental Response Trust Site Henderson, Nevada

> **APPENDIX D DATA VALIDATION SUMMARY REPORT (DVSR)**

Data Validation Summary Report January through June 2015 Annual Remedial Performance Sampling Nevada Environmental Response Trust (NERT) Henderson, Nevada

Prepared for

Ramboll Environ Emeryville, California

Prepared by

Laboratory Data Consultants, Inc. 27010 Loker Avenue West, Suite 220 Carlsbad, California 92010

September 9, 2015

Table of Contents

LIST OF TABLES

- TABLE I Sample Cross-Reference
TABLE II Stage 2B & Stage 4 Valid
- TABLE II Stage 2B & Stage 4 Validation Elements
TABLE III Reason Codes and Definitions
- Reason Codes and Definitions
- TABLE IV Overall Qualified Results

ATTACHMENT

ATTACHMENT A – Metals Data Validation Report ATTACHMENT B – Wet Chemistry Data Validation Report

LIST OF ACRONYMS AND ABBREVIATIONS

1.0 INTRODUCTION

This data validation summary report (DVSR) has been prepared by Laboratory Data Consultants, Inc. (LDC) to assess the validity and usability of laboratory analytical data from the Annual Remedial Performance Sampling conducted at the Nevada Environmental Response Trust (NERT) site in Henderson, Nevada. The assessment was performed by Ramboll Environ as a part of the *Revised Phase B Quality Assurance Project Plan Tronox LLC Facility, Henderson, Nevada* dated May 2009 and included the collection and analyses of 592 environmental and quality control (QC) samples. The analyses were performed by the following methods:

Metals by Environmental Protection Agency (EPA) Method 200.7

Wet Chemistry: Hexavalent Chromium by EPA Method 218.6 Chloride, Nitrate as Nitrogen, Nitrite as Nitrogen, and Sulfate (Anions) by EPA Method 300.0 Chlorate by EPA Method 300.1B Perchlorate by EPA Method 314.0 Ammonia as Nitrogen by EPA Method 350.1 Phenolics by EPA Method 420.1 Nitrate/Nitrite as Nitrogen and Total Inorganic Nitrogen (TIN) by Calculation Method Specific Conductance by Standard Method 2510 Total Dissolved Solids (TDS) by Standard Method 2540C pH by Standard Method 4500 H+B Total Organic Carbon (TOC) by Standard Method 5310C Total Organic Halides (TOX) by EPA SW-846 Method 9020B

Laboratory analytical services were provided by TestAmerica, Inc. The samples were grouped into sample delivery groups (SDGs). The water samples are associated with QA/QC samples designed to document the data quality of the entire SDG or a sub-group of samples within an SDG. Table I is a cross-reference table listing each sample, analysis, SDG, collection date, laboratory sample number, matrix, and validation level. Table II is a reference table that identifies the QC elements reviewed for each validation level per method, as applicable.

The laboratory analytical data were validated in accordance with procedures described in the Nevada Division of Environmental Protection (NDEP) *Data Verification and Validation Requirements - Supplement* established for the BMI Plant Sites and Common Areas Projects, Henderson, Nevada, April 13, 2009. Consistent with the NDEP requirements, approximately ninety percent of the analytical data (412 of the 459 samples) were validated according to Stage 2B data validation procedures and ten percent of the analytical data (47 of the 459 samples) were validated according to Stage 4 data validation procedures. The analytical data were evaluated for quality assurance and quality control (QA/QC) based on the following documents: *Basic Remediation Company (BRC) Standard Operating Procedures (SOP) 40 Data Review/Validation,* Revision 4, May 2009; *Revised Phase B Quality Assurance Project Plan Tronox LLC Facility, Henderson, Nevada (*QAPP), Revision, May 2009; Nevada Department of Environmental Protection (NDEP) *Revised Guidance on Qualifying Data due to Blank Contamination for the BMI Complex and Common Areas*, January 5 2012; *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, October 2004; and the *EPA SW 846 Third Edition, Test Methods for Evaluating Solid Waste,* update I, July 1992; update IIA, August 1993; update II, September 1994; update IIB, January 1995; update III, December 1996; update IV, February 2007.

This report summarizes the QA/QC evaluation of the data according to precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) relative to the project data quality objectives (DQOs). This report provides a quantitative and qualitative assessment of the data and identifies potential sources of error, uncertainty, and bias that may affect the overall usability.

The PARCCS summary report evaluates and summarizes the results of QA/QC data validation for the entire sampling program. Each analytical fraction has a separate section for each of the PARCCS criteria. These sections interpret specific QC deviations and their effects on both individual data points and the analyses as a whole. Section 5.0 presents a summary of the PARCCS criteria by comparing quantitative parameters with acceptability criteria defined in the project DQO's. Qualitative PARCCS criteria are also summarized in this section.

Precision and Accuracy of Environmental Data

Environmental data quality depends on sample collection procedures, analytical methods and instrumentation, documentation, and sample matrix properties. Both sampling procedures and laboratory analyses contain potential sources of uncertainty, error, and/or bias, which affect the overall quality of a measurement. Errors for sample data may result from incomplete equipment decontamination, inappropriate sampling techniques, sample heterogeneity, improper filtering, and improper preservation. The accuracy of analytical results is dependent on selecting appropriate analytical methods, maintaining equipment properly, and complying with QC requirements. The sample matrix also is an important factor in the ability to obtain precise and accurate results within a given media.

Environmental and laboratory QA/QC samples assess the effects of sampling procedures and evaluate laboratory contamination, laboratory performance, and matrix effects. QA/QC samples include: equipment blanks (EBs), field blanks (FBs), field duplicates (FDs), method blanks, laboratory control samples/laboratory control sample duplicates (LCS/LCSDs), laboratory duplicates (DUP), and matrix spike/matrix spike duplicates (MS/MSDs).

Before conducting the PARCCS evaluation, the analytical data were validated according to the BRC SOP-40 (July 2007), QAPP (May 2009), Functional Guidelines (USEPA 2004), and EPA SW 846 Test Methods. Samples not meeting the acceptance criteria were qualified with a flag, an abbreviation indicating a deficiency with the data. The following are flags used in data validation.

- J- Estimated The associated numerical value is an estimated quantity with a negative bias. The analyte was detected but the reported value may not be accurate or precise.
- J+ Estimated The associated numerical value is an estimated quantity with a positive bias. The analyte was detected but the reported value may not be accurate or precise.
- J Estimated The associated numerical value is an estimated quantity. It is not possible to assess the direction of the potential bias. The analyte was detected but the reported value may not be accurate or precise. The "J" qualification indicates the data fell outside the QC limits or any result that is detected in an environmental sample and associated blank at less than the required action level, but the exceedance was not sufficient to cause rejection of the data.
- R Rejected The data is unusable (the compound or analyte may or may not be present). Use of the "R" qualifier indicates a significant variance from functional guideline acceptance criteria. Either resampling or reanalysis is necessary to determine the presence or absence of the rejected analyte. The "R" designation is also applied to yield only one complete set of data for a given sample and eliminate redundant data.
- U Nondetected Analyses were performed for the compound or analyte, but it was not detected.
- UJ Estimated/Nondetected Analyses were performed for the compound or analyte, but it was not detected and the sample quantitation or detection limit is an estimated quantity due to poor accuracy or precision. This qualification is also used to flag possible false negative results in the case where low bias in the analytical system is indicated by low calibration response, surrogate, or other spike recovery.
- DNR Do Not Report A more appropriate result is reported from another analysis or dilution.
- None Indicates the data was not significantly impacted by the finding, therefore qualification was not required.
- A Indicates the finding is based upon technical validation criteria.
- P Indicates the finding is related to a protocol/contractual deviation.

The hierarchy of flags is listed below:

Table III lists the reason codes used. Reason codes explain why flags have been applied and identify possible limitations of data use. Reason codes are cumulative except when one of the flags is R then only the reason code associated to the R flag will be used.

Table IV presents the overall qualified results after all the flags or validation qualifiers and associated reason codes have been applied.

Once the data are reviewed and qualified according to the BRC SOP-40, QAPP, functional guidelines, and EPA Test Methods, the data set is then evaluated using PARCCS criteria. PARCCS criteria provide an evaluation of overall data usability. The following is a discussion of PARCCS criteria as related to the project DQOs.

Precision is a measure of the agreement or reproducibility of analytical results under a given set of conditions. It is a quantity that cannot be measured directly but is calculated from percent recovery data. Precision is expressed as the relative percent difference (RPD):

 $RPD = (D1-D2)/{1/2(D1+D2)}$ $X 100$

where:

 $D1$ = reported concentration for the sample

 $D2$ = reported concentration for the duplicate

Precision is primarily assessed by calculating an RPD from the percent recoveries of the spiked compounds for each sample in the MS/MSD pair. In the absence of an MS/MSD pair, a laboratory duplicate or LCS/LCSD pair can be analyzed as an alternative means of assessing precision. An additional measure of sampling precision was obtained by collecting and analyzing field duplicate samples, which were compared using the RPD result as the evaluation criteria.

MS and MSD samples are field samples spiked by the laboratory with target analytes prior to preparation and analysis. These samples measure the overall efficiency of the analytical method in recovering target analytes from an environmental matrix. A LCS is similar to an MS/MSD sample in that the LCS is spiked with the same target analytes prior to preparation and analysis. However, the LCS is prepared using a controlled interference-free matrix instead of a field sample aliquot. Laboratory reagent water is used to prepare aqueous LCS. The LCS measures laboratory efficiency in recovering target analytes from either an aqueous matrix in the absence of matrix interferences.

One primary sample is analyzed and accompanied by an unspiked laboratory duplicate. The data reviewer compares the reported results of the primary analysis and the laboratory duplicate, then calculates RPDs, which are used to assess laboratory precision.

Laboratory and field sampling precision are evaluated by calculating RPDs for aqueous field sample duplicate pairs. The sampler collects two field samples at the same location and under identically controlled conditions. The laboratory then analyzes the samples under identical conditions.

An RPD outside the numerical QC limit in either MS/MSD samples or LCS/LCSD indicates imprecision. Imprecision is the variance in the consistency with which the laboratory arrives at a particular reported result. Thus, the actual analyte concentration may be higher or lower than the reported result.

Possible causes of poor precision include sample matrix interference, improper sample collection or handling, inconsistent sample preparation, and poor instrument stability. In some duplicate pairs, results maybe reported in either the primary or duplicate samples at levels below the practical quantitation limit (PQL) or non-detected. Since these values are considered to be estimates, RPD exceedances from these duplicate pairs do not suggest a significant impact on the data quality.

Accuracy is a measure of the agreement of an experimental determination and the true value of the parameter being measured. It is used to identify bias in a given measurement system. Recoveries outside acceptable QC limits may be caused by factors such as instrumentation, analyst error, or matrix interference. Accuracy is assessed through the analysis of MS, MSD, LCS, and LCSD. In some cases, samples from multiple SDGs were within one QC batch and therefore are associated with the same laboratory QC samples. Accuracy of inorganic analyses is determined using the percent recoveries of MS and LCS analyses.

Percent recovery (%R) is calculated using the following equation:

$$
%R = (A-B)/C \times 100
$$

where:

 $A =$ measured concentration in the spiked sample

 $B =$ measured concentration of the spike compound in the unspiked sample

 $C =$ concentration of the spike

The percent recovery of each analyte spiked in MS/MSD samples and LCS/LCSD is evaluated with the acceptance criteria specified by the previously noted documents. Spike recoveries outside the acceptable QC accuracy limits provide an indication of bias, where the reported data may overestimate or underestimate the actual concentration of compounds detected or quantitation limits reported for environmental samples.

Representativeness is a qualitative parameter that expresses the degree to which the sample data are characteristic of a population. It is evaluated by reviewing the QC results of blanks, samples and holding times. Positive detects of compounds in the blank samples identify compounds that may have been introduced into the samples during sample collection, transport, preparation, or analysis. The QA/QC blanks collected and analyzed are method blanks, calibration blanks, EBs, and FBs.

A method blank is a laboratory grade water or solid matrix that contains the method reagents and has undergone the same preparation and analysis as the environmental samples. The method blank provides a measure of the combined contamination derived from the laboratory source water, glassware, instruments, reagents, and sample preparation steps. Method blanks are prepared for each sample of a similar matrix extracted by the same method at a similar concentration level.

Initial and continuing calibration blanks (ICB/CCBs) consist of acidified laboratory grade water, which are injected at the beginning and at a regular frequency during each 12 - hour sample analysis run. These blanks estimate residual contaminants from the previous sample or standards analysis and measure baseline shifts that commonly occur in emission and absorption spectroscopy.

Equipment blanks consist of analyte-free water poured over or through the sample collection equipment. The water is collected in a sample container for laboratory analysis. These blanks are collected after the sampling equipment is decontaminated and measure efficiency of the decontamination procedure. Equipment blanks were collected and analyzed for all target analytes.

Field blanks consist of analyte-free source water stored at the sample collection site. The water is collected from each source water used during each sampling event. Field blanks were collected and analyzed for all target analytes.

Contaminants found in both the environmental sample and the blank sample are assumed to be laboratory artifacts if both values are less than the PQL or if a sample result and blank contaminant value were greater than the PQL and less than 10 times the blank contaminant value. The blanks and associated samples were evaluated according to the NDEP *BMI Plant Sites and Common Areas Projects, Henderson, Nevada, Revised Guidance on Qualifying Data due to Blank Contamination for the BMI Complex and Common Areas*, January 5 2012.

Holding times are evaluated to assure that the sample integrity is intact for accurate sample preparation and analysis. Holding times will be specific for each method and matrix analyzed. Holding time exceedance can cause loss of sample constituents due to biodegradation, precipitation, volatization, and chemical degradation. In accordance with EPA guidance (USEPA 2004), sample results for analyses that were performed after the method holding time but less than two times the method holding time were qualified as estimated (J- or UJ) and sample results for analyses that were performed after two times the method holding time were qualified as rejected (R), with the exception of specific pH results detailed in Attachment B, Section I. Although the holding time for some pH analyses was exceeded by more than two times the holding time, using professional judgment the associated sample results were qualified as estimated (J/UJ) because the sample condition and integrity was maintained during collection, transport, and storage.

Comparability is a qualitative expression of the confidence with which one data set may be compared to another. It provides an assessment of the equivalence of the analytical results to data obtained from other analyses. It is important that data sets be comparable if they are used in conjunction with other data sets. The factors affecting comparability include the following: sample collection and handling techniques, matrix type, and analytical method. If these aspects of sampling and analysis are carried out according to standard analytical procedures, the data are considered comparable. Comparability is also dependent upon other PARCCS criteria, because only when precision, accuracy, and representativeness are known can data sets be compared with confidence.

Completeness is defined as the percentage of acceptable sample results compared to the total number of sample results. Completeness is evaluated to determine if an acceptable amount of usable data were obtained so that a valid scientific site assessment can be completed. Completeness equals the total number of sample results for each fraction minus the total number of rejected sample results divided by the total number of sample results multiplied by 100. As specified in the project DQOs, the goal for completeness for target analytes in each analytical fraction is 90 percent.

Percent completeness is calculated using the following equation:

$$
\%C = (T - R)/T \times 100
$$

where:

 $\%C$ = percent completeness

 $T =$ total number of sample results

 R = total number of rejected sample results

Completeness is also determined by comparing the planned number of samples per method and matrix as specified in the QAPP, with the number determined above.

Sensitivity is the ability of an analytical method or instrument to discriminate between measurement responses representing different concentrations. This capability is established during the planning phase to meet the DQOs. It is important that calibration requirements, detection limits (DLs), and PQLs presented in the QAPP are achieved and that target analytes can be detected at concentrations necessary to support the DQOs. The method detection limits (MDLs) represent the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. Sample quantitation limits (SQLs) are adjusted MDL values that reflect sample specific actions, such as dilutions or varying aliquot sizes. PQLs are the lowest level at which the entire analytical system gives a recognizable signal and acceptable calibration point for the analyte. The laboratory is required to report detected analytes down to the MDL for this project. The laboratory uses a formatter that reports estimated values down to the MDL. In addition, sample results are compared to method blank and field blank results to identify potential effects of laboratory background and field procedures on sensitivity.

The following sections present a review of QC data for each analytical method.

2.0 METALS

A total of 384 water samples were analyzed for metals by EPA Method 200.7. All metals data were assessed to be valid since none of the 406 total results were rejected based on holding time and QC exceedances. This section discusses the QA/QC supporting documentation as defined by the PARCCS criteria and evaluated based on the DQOs.

2.1 Precision and Accuracy

2.1.1 Instrument Calibration

Initial and continuing calibration verification results provide a means of evaluating accuracy within a particular SDG. Correlation coefficient (r) and percent recovery (%R) are the two major parameters used to measure the effectiveness of instrument calibration. The correlation coefficient indicates the linearity of the calibration curve. %R is used to verify the ongoing calibration acceptability of the analytical system. The most critical of the two calibration parameters, r, has the potential to affect data accuracy across an SDG when it is outside the acceptable QC limits. %R exceedances suggest more routine instrumental anomalies, which typically impact all sample results for the affected analytes.

The correlation coefficients in the initial calibrations were within the acceptance criteria of ≥ 0.995 and the %Rs in the continuing calibration verifications met the acceptance criteria of 90-110%.

2.1.2 MS/MSD Samples

Due to low MS/MSD %Rs outside of acceptance criteria as stated in the QAPP, the boron results for samples M-5A and M-7B (both sampled on 5/22/15) and the chromium result for sample ART-7A (sampled on 2/13/15) were qualified as detected estimated (J-/J). The details regarding the qualification of results are presented in Attachment A, Section VI.

2.1.3 LCS/LCSD Samples

All LCS/LCSD %Rs and RPDs met acceptance criteria as stated in the QAPP.

2.1.4 ICP Interference Check Sample

All ICP interference check %Rs met acceptance criteria as stated in the QAPP.

2.1.5 FD Samples

The field duplicate samples were evaluated for acceptable precision with RPDs or difference in instances the results were less than five times the reporting limit for the compounds. The field duplicate RPDs or differences were within the acceptance criteria. The field duplicate RPDs or differences are presented in detail in Attachment A, Section X.

2.1.6 Analyte Quantitation and Target Identification

Raw data were evaluated for the Stage 4 samples. All analyte quantitation and target identifications were acceptable.

2.2 Representativeness

2.2.1 Sample Preservation and Holding Times

The evaluation of holding times to verify compliance with the method was conducted. All samples met the 180-day analysis holding time criteria for metals.

2.2.2 Blanks

Method blanks, ICB/CCBs, EBs, and FBs were analyzed to evaluate representativeness. The concentration for an individual target compound in any of the types of QA/QC blanks was used for data qualification.

If contaminants were detected in a blank, corrective actions were made for the chemical analytical data during data validation. The corrective action consisted of amending the laboratory reported results based on the following criteria.

Results Below the PQL If a sample result and blank contaminant value were less than the PQL, the sample result was amended as estimated (J) at the concentration reported in the sample results.

Results Above the PQL If a sample result and blank contaminant value were greater than the PQL and less than 10 times the blank contaminant value, the sample result was qualified as detected estimated (J+) at the concentration reported in the sample results.

No Action If blank contaminant values were less than the PQL and associated sample results were greater than the PQL, or if blank contaminant values were greater than the PQL and associated sample results were greater than 10 times the blank contaminant value, the result was not amended.

2.2.2.1 Method and Calibration Blanks

No contaminants were detected in the method or calibration blanks for this analysis.

2.2.2.2 EBs and FBs

The chromium result in sample PC-143 (sampled on 5/21/15) was qualified as detected estimated (J) due to contaminants detected in the equipment blanks. No contaminants were detected in the field blanks for this analysis. The details regarding the qualification of results are presented in Attachment A, Section V.

2.3 Comparability

The laboratory used standard analytical methods for all of the analyses. In all cases, the SQLs attained were at or below the PQLs. Target compounds detected below the PQLs flagged (J) by the laboratory should be considered estimated. The comparability of the metals data is regarded as acceptable.

2.4 Completeness

The completeness level attained for metal field samples was 100 percent. This percentage was calculated as the total number of accepted sample results divided by the total number of sample results multiplied by 100.

2.5 Sensitivity

The calibration was evaluated for instrument sensitivity and was determined to be technically acceptable. All laboratory PQLs met the specified requirements described in the QAPP.

3.0 WET CHEMISTRY

A total of 40 water samples were analyzed for hexavalent chromium by EPA Method 218.6; 31 water samples were analyzed for anions by EPA Method 300.0; 26 water samples were analyzed for chlorate by EPA Method 300.1B; 592 water samples were analyzed for perchlorate by EPA Method 314.0; 4 water samples were analyzed for phenolics by EPA Method 420.1, specific conductance by Standard Method 2510, TOC by Standard Method 5310C, and TOX by EPA SW-846 Method 9020B; 2 water samples were analyzed for ammonia as nitrogen by EPA Method 350.1, nitrate/nitrite as nitrogen by EPA Method 353.2, and TIN by Calculation Method; 587 water samples were analyzed for TDS by Standard Method 2540C; and 407 water samples were analyzed for pH by Standard Method 4500 H+B. All wet chemistry data were assessed to be valid with the exception of two of the 1,713 total results which were rejected based on holding time exceedances. This section discusses the QA/QC supporting documentation as defined by the PARCCS criteria and evaluated based on the DQOs.

3.1 Precision and Accuracy

3.1.1 Instrument Calibration

As previously discussed in Section 2.1.1, initial and continuing calibration results provide a means of evaluating accuracy.

Instrument calibrations were evaluated for all wet chemistry methods. The correlation coefficients in the initial calibrations were within the acceptance criteria of \geq 0.995 and the %Rs in the continuing calibration verifications met the acceptance criteria of 90-110%.

3.1.2 Surrogate

Surrogates were evaluated for chlorate analysis by EPA Method 300.1B. All surrogate %Rs met the acceptance criteria as stated in the QAPP.

3.1.3 MS/MSD Samples

MS/MSD samples were evaluated for hexavalent chromium analysis by EPA Method 218.6, anions by EPA Method 300.0, chlorate by EPA Method 300.1B, perchlorate by EPA Method 314.0, ammonia as nitrogen by EPA Method 350.1, and phenolics by EPA Method 420.1. Due to high MS/MSD %Rs outside of acceptance criteria as stated in the QAPP, the perchlorate results in samples PC-82 (sampled on 5/6/15) and PC-134A (sampled on $5/7/15$) were qualified as detected estimated $(J+)$. The details regarding the qualification of results are presented in Attachment B, Section VII.

3.1.4 DUP Samples

DUP samples were evaluated for specific conductance analysis by Standard Method 2510, TDS by Standard Method 2540C, and pH by Standard Method 4500 H+B. All DUP RPDs met the acceptance criteria as stated in the QAPP.

3.1.5 LCS Samples

LCS samples were evaluated for all wet chemistry methods. All LCS %Rs met the acceptance criteria as stated in the QAPP.

3.1.6 FD Samples

FD samples were evaluated for hexavalent chromium by EPA Method 218.6, anions by EPA Method 300.0, chlorate by EPA Method 300.1B, perchlorate by EPA Method 314.0, TDS by Standard Method 2540C, and pH by Standard Method 4500 H+B. The field duplicate samples were evaluated for acceptable precision with RPDs or difference in instances the results were less than five times the reporting limit for the compounds. The nitrate as nitrogen results were qualified as detected estimated (J) due to difference outside of acceptance criteria in field duplicate pair M-12A and DUP-7 (both sampled on 6/5/15). The details regarding the qualification of results are presented in Attachment B, Section X.

3.1.7 Analyte Quantitation and Target Identification

Raw data were evaluated for the Stage 4 samples. All analyte quantitation and target identifications were acceptable.

In instances where data exceeded the calibration range and was subsequently diluted, the data was qualified as not reportable by the validators in order to yield only one complete set of data for a given sample. The details regarding the qualification of results are presented in Attachment B, Section XII.

3.2 Representativeness

3.2.1 Sample Preservation and Holding Times

The evaluation of holding times to verify compliance with all wet chemistry methods was conducted. All water samples met the 48-hour analysis holding time criteria for nitrate as nitrogen and nitrite as nitrogen, the 7-day analysis holding time criteria for TDS, and the 28-day analysis holding time criteria for ammonia as nitrogen, chlorate, chloride, sulfate, phenolics, specific conductance, TOC, TOX, and perchlorate.

Due to a severe holding time criteria exceedance $(2X)$ holding time criteria), the hexavalent chromium result for samples EB-4 and FB-1 (both sampled on 5/8/15) were qualified as rejected (R). Additionally, 177 results for hexavalent chromium and pH were qualified as detected estimated (J-/J) or non-detected estimated (UJ). The analysis holding time criteria for water samples is 24 hours for hexavalent chromium and 48 hours for pH. The details regarding the qualification of results are presented in Attachment B, Section I.

3.2.2 Blanks

As previously discussed in Section 2.2.2, method blanks, ICB/CCBs, EBs, and FBs were analyzed to evaluate representativeness.

3.2.2.1 Method and Calibration Blanks

No data were qualified due to contaminants detected in the method or calibration blanks for this analysis.

3.2.2.2 EBs and FBs

Twenty three perchlorate and TDS results were qualified as detected estimated $(J₊)$ due to contaminants detected in the equipment blanks. No contaminants were detected in the field blanks for this analysis. The details regarding the qualification of results are presented in Attachment B, Section V.

3.3 Comparability

The laboratory used standard analytical methods for all of the analyses. In all cases, the SQLs attained were at or below the PQLs. Target compounds detected below the PQLs flagged (J) by the laboratory should be considered estimated. The comparability of the data is regarded as acceptable.

3.4 Completeness

The completeness level attained for wet chemistry field samples was 99.9 percent. This percentage was calculated as the total number of accepted sample results divided by the total number of sample results multiplied by 100.

3.5 Sensitivity

The calibration was evaluated for instrument sensitivity and was determined to be technically acceptable. All laboratory PQLs met the specified requirements described in the QAPP.

4.0 VARIANCES IN ANALYTICAL PERFORMANCE

The laboratory used standard analytical methods for all of the analyses throughout the project. No systematic variances in analytical performance were noted in the laboratory case narratives.

5.0 SUMMARY OF PARCCS CRITERIA

The validation reports present the PARCCS results for all SDGs. Each PARCCS criterion is discussed in detail in the following sections.

5.1 Precision and Accuracy

Precision and accuracy were evaluated using data quality indicators such as calibration, surrogates, MS/MSD, DUP, LCS/LCSD, and field duplicates. The precision and accuracy of the data set were considered acceptable after integration of result qualification.

All calibrations were performed as required and met the acceptance criteria. All surrogate, MS/MSD, DUP, LCS, and field duplicate percent recoveries, RPDs, and difference met acceptance criteria with the exceptions noted in Sections 2.1.2, 3.1.3, and 3.1.6. All ICP interference check sample %Rs met acceptance criteria.

5.2 Representativeness

All samples for each method and matrix were evaluated for holding time compliance. All samples were associated with a method blank in each individual SDG. The representativeness of the project data is considered acceptable after integration of result qualification.

5.3 Comparability

Sampling frequency requirements were met in obtaining necessary equipment blanks, field blanks and field duplicates. The laboratory used standard analytical methods for the analyses. The analytical results were reported in correct standard units. Sample integrity criteria were met. Sample preservation and holding times were within QC criteria with the exceptions noted in Section 3.2.1. The overall comparability is considered acceptable after integration of result qualification.

5.4 Completeness

Of the 2,119 total analytes reported, two sample results were rejected. The completeness for the SDGs is as follows:

The completeness percentage based on rejected data met the 90 percent DQO goal.

5.5 Sensitivity

Sensitivity was achieved by the laboratory to support the DQOs. Calibration concentrations and PQLs met the project requirements and low level contamination in the method blanks, calibration blanks, equipment blanks, and field blanks did not affect sensitivity.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The analytical data quality assessment for the water sample laboratory analytical results generated during the Annual Remedial Performance Sampling at the Nevada Environmental Response Trust (NERT) site in Henderson, Nevada established that the overall project requirements and completeness levels were met. The sample results that were found to be rejected (R) are unusable for all purposes. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the Stage 2B and Stage 4 data validation all other results are considered valid and usable for all purposes.

7.0 REFERENCES

- NDEP 2009. Data Verification and Validation Requirements Supplement established for the BMI Plant Sites and Common Areas Projects, Henderson, Nevada. April 13.
- NDEP 2012. Revised Guidance on Qualifying Data due to Blank Contamination for the BMI Complex and Common Areas. January 5.
- Basic Remediation Company (BRC), 2009. Standard Operating Procedures, SOP-40 Data Review/Validation. Revision 4. May.
- Revised Phase B Quality Assurance Project Plan Tronox LLC Facility, Henderson, Nevada (QAPP), Revision. May 2009.
- Region 9 Superfund Data Evaluation/Validation Guidance, R6QA/006.1, Draft. December 2001.
- USEPA 2004. Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. October.
- ____.1983. EPA Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, Cincinnati, Ohio. March.
- ____.1996. EPA SW 846 Third Edition, Test Methods for Evaluating Solid Waste, update I, July 1992; update IIA, August 1993; update II, September 1994; update IIB, January 1995; update III, December 1996; update IV, February 2007.
- (Eaton et al., 1998) *Standard Method for the Examination of Water and Wastewater* (20th ed.). Washington, DC: American Public Health Association.

TABLE I

TABLE II

 $\sqrt{\ }$ = Reviewed for Stage 2B review

 $N/A = Not$ applicable to method or not performed during this sampling event

- = Not applicable for Stage 2B review

Table IIb. Stage 4 Validation Elements

 $\sqrt{\ }$ = Reviewed for Stage 4 review

 $N/A = Not$ applicable to method or not performed during this sampling event

TABLE III

Table III. Qualification Codes and Definitions

TABLE IV

ATTACHMENT A

Metals Data Validation Report

Metals by EPA Method 200.7

I. Sample Receipt and Technical Holding Times

All samples were received in good condition.

All technical holding time requirements were met.

II. Instrument Calibration

Initial and continuing calibrations were performed as required by the method.

The initial calibration verification (ICV) and continuing calibration verification (CCV) standards were within QC limits.

III. ICP Interference Check Sample (ICS) Analysis

The frequency of ICS analysis was met. All criteria were within QC limits.

IV. Laboratory Blanks

Laboratory blanks were analyzed as required by the method. No contaminants were found in the laboratory blanks.

V. Field Blanks

Samples EB-1 (from SDGs 440-102831-1 and 440-108808-1), EB-2 (from SDGs 440- 102951-1 and 440-108986-1), EB-03 (from SDG 440-109155-1), EB-4 (from SDG 440- 109318-1), EB-8 (from SDG 440-109936-1), EB-9 (from SDG 440-110520-1), EB-10 (from SDG 440-110670-1), E. Blank (from SDG 440-110834-1), EB-7 (from SDG 440- 110962-1), EB-5 (from SDG 440-111102-1), EB-11 (from SDG 440-111211-1), EB-13 (from SDG 440-111334-1), EB-12 (from SDG 440-111455-1), EB-14 (from SDG 440- 111754-1), EB-15 (from SDG 440-111886-1), and EB-16 (from SDG 440-112107-1) were identified as equipment blanks. No contaminants were found with the following exceptions:

Samples FB-1 (from SDGs 440-102689-1 and 440-109318-1) and FB-2 (from SDG 440- 111211-1) were identified as field blanks. No contaminants were found.

Sample concentrations were compared to concentrations detected in the field blanks as required by the QAPP. No sample data was qualified with the following exceptions:

VI. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) sample analysis was performed on associated project samples. Percent recoveries (%R) were within QC limits with the following exceptions:

Relative percent differences (RPD) were within QC limits.

VII. Duplicate Sample Analysis

The laboratory has indicated that there were no duplicate (DUP) analyses specified for the samples in these SDGs, and therefore duplicate analyses were not performed for these SDGs.

VIII. ICP Serial Dilution

ICP serial dilution was not performed for these SDGs.

IX. Laboratory Control Samples

Laboratory control samples (LCS) and laboratory control samples duplicates (LCSD) were analyzed as required by the method. Percent recoveries (%R) were within QC limits. Relative percent differences (RPD) were within QC limits.

X. Field Duplicates

Samples M-44 and DUP-1 (from SDG 440-102689-1), samples M-68 and DUP-2 (from SDG 440-102951-1), samples M-81A and DUP-4 (from SDG 440-102951-1), samples M-37 and DUP-3 (from SDG 440-103031-1), samples M-66 and DUP-1 (from SDG 440- 109318-1), samples PC-144 and DUP-1 (from SDG 440-110670-1), samples PC-148 and DUP-2 (from SDG 440-110832-1), samples M-25 and DUP-3 (from SDG 440- 110962-1), samples M-44 and DUP-4 (from SDG 440-111102-1), samples M-124 and DUP-5 (from SDG 440-111886-1) and samples M-10 (from SDG 440-111887-1) and DUP-6 (from SDG 440-111886-1), and samples M-12A and DUP-7 (from SDG 440- 112107-1) were identified as field duplicates. No results were detected in any of the samples with the following exceptions:

XI. Sample Result Verification

All sample result verifications were acceptable for samples which underwent Stage 4 validation. Raw data were not reviewed for Stage 2B validation.

XII. Overall Assessment of Data

The analysis was conducted within all specifications of the method. No results were rejected in these SDGs.

Due to MS/MSD %R, data were qualified as estimated in three samples.

Due to equipment blank contamination, data were qualified as estimated in one sample.

The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the data validation all other results are considered valid and usable for all purposes.

2015 Annual Remedial Performance Sampling

Metals - Data Qualification Summary - SDGs 440-100474-1, 440-101558-1, 440- 101655-1, 440-101929-1, 440-102243-1, 440-102526-1, 440-102689-1, 440-102831-1, 440-102951-1, 440-103031-1, 440-103261-1, 440-103265-1, 440-108677-1, 440- 108680-1, 440-108808-1, 440-108986-1, 440-109155-1, 440-109318-1, 440-109936-1, 440-110425-1, 440-110520-1, 440-110604-1, 440-110673-1, 440-110832-1, 440- 110834-1, 440-110915-1, 440-110962-1, 440-111099-1, 440-111102-1, 440-111211-1, 440-111333-1, 440-111334-1, 440-111455-1, 440-111754-1, 440-111886-1, 440- 111887-1, 440-112107-1, 440-112626-1

2015 Annual Remedial Performance Sampling

Metals - Laboratory Blank Data Qualification Summary - SDGs 440-100474-1, 440- 101558-1, 440-101655-1, 440-101929-1, 440-102243-1, 440-102526-1, 440-102689-1, 440-102831-1, 440-102951-1, 440-103031-1, 440-103261-1, 440-103265-1, 440- 108677-1, 440-108680-1, 440-108808-1, 440-108986-1, 440-109155-1, 440-109318-1, 440-109936-1, 440-110425-1, 440-110520-1, 440-110604-1, 440-110673-1, 440- 110832-1, 440-110834-1, 440-110915-1, 440-110962-1, 440-111099-1, 440-111102-1, 440-111211-1, 440-111333-1, 440-111334-1, 440-111455-1, 440-111754-1, 440- 111886-1, 440-111887-1, 440-112107-1, 440-112626-1

No Sample Data Qualified in these SDGs

2015 Annual Remedial Performance Sampling

Metals - Field Blank Data Qualification Summary - SDGs 440-100474-1, 440- 101558-1, 440-101655-1, 440-101929-1, 440-102243-1, 440-102526-1, 440-102689-1, 440-102831-1, 440-102951-1, 440-103031-1, 440-103261-1, 440-103265-1, 440- 108677-1, 440-108680-1, 440-108808-1, 440-108986-1, 440-109155-1, 440-109318-1, 440-109936-1, 440-110425-1, 440-110520-1, 440-110604-1, 440-110673-1, 440- 110832-1, 440-110834-1, 440-110915-1, 440-110962-1, 440-111099-1, 440-111102-1, 440-111211-1, 440-111333-1, 440-111334-1, 440-111455-1, 440-111754-1, 440- 111886-1, 440-111887-1, 440-112107-1, 440-112626-1

ATTACHMENT B

Wet Chemistry Data Validation Report

Hexavalent Chromium by EPA Method 218.6 Chloride, Nitrate as Nitrogen, Nitrite as Nitrogen, and Sulfate by EPA Method 300.0 Chlorate by EPA Method 300.1B Perchlorate by EPA Method 314.0 Ammonia as Nitrogen by EPA Method 350.1 Phenolics by EPA Method 420.1 Nitrate/Nitrite as Nitrogen and Total Inorganic Nitrogen by Calculation Method Specific Conductance by Standard Method 2510 Total Dissolved Solids by Standard Method 2540C pH by Standard Method 4500 H+B Total Organic Carbon by Standard Method 5310C Total Organic Halides by EPA SW-846 Method 9020B

I. Sample Receipt and Technical Holding Times

All samples were received in good condition.

All technical holding time requirements were met with the following exceptions:

II. Initial Calibration

All criteria for the initial calibration of each method were met.

III. Continuing Calibration

Continuing calibration frequency and analysis criteria were met for each method when applicable.

IV. Laboratory Blanks

Laboratory blanks were analyzed as required by the methods. No contaminants were found in the laboratory blanks with the following exceptions:

Sample concentrations were compared to concentrations detected in the method blanks as required by the QAPP. No sample data was qualified.

V. Field Blanks

Samples MEB-1 (from SDGs 440-99068-1, 440-101929-1, 440-104381-1, 440-107507- 1, and 440-113481-1), EB-1 (from SDGs 440-102831-1 and 440-108808-1), EB-2 (from SDGs 440-102951-1 and 440-108986-1), EB-03 (from SDG 440-109155-1), EB-4 (from SDG 440-109318-1), EB-8 (from SDG 440-109936-1), EB-9 (from SDG 440-110520-1), EB-10 (from SDG 440-110670-1), EB-6 (from SDG 440-110832-1), E. Blank (from SDG 440-110834-1), EB-7 (from SDG 440-110962-1), EB-5 (from SDG 440-111102-1), EB-11 (from SDG 440-111211-1), EB-13 (from SDG 440-111334-1), EB-12 (from SDG 440- 111455-1), EB-14 (from SDG 440-111754-1), EB-15 (from SDG 440-111886-1), and EB-16 (from SDG 440-112107-1) were identified as equipment blanks. No contaminants were found with the following exceptions:

Samples FB-1 (from SDGs 440-102689-1 and 440-109318-1) and FB-2 (from SDG 440- 111211-1) was identified as a field blank. No contaminants were found.

Sample concentrations were compared to concentrations detected in the field blanks as required by the QAPP. No sample data was qualified with the following exceptions:

VI. Surrogates

Surrogates were added to all samples as required by the method. All surrogate recoveries (%R) were within QC limits.

VII. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) sample analysis was performed on an associated project sample. Percent recoveries (%R) were within QC limits with the following exceptions:

Relative percent differences (RPD) were within QC limits.

VIII. Duplicates

Duplicate (DUP) sample analysis was performed on associated project samples. Results were within QC limits.

IX. Laboratory Control Samples

Laboratory control samples (LCS) were analyzed as required by the method. Percent recoveries (%R) were within QC limits.

X. Field Duplicates

Samples M-44 and DUP-1 (from SDG 440-102689-1), samples M-68 and DUP-2 (from SDG 440-102951-1), samples M-81A and DUP-4 (from SDG 440-102951-1), samples M-37 and DUP-3 (from SDG 440-103031-1), samples M-66 and DUP-1 (from SDG 440- 109318-1), samples PC-144 and DUP-1 (from SDG 440-110670-1), samples PC-148 and DUP-2 (from SDG 440-110832-1), samples M-25 and DUP-3 (from SDG 440- 110962-1), samples M-44 and DUP-4 (from SDG 440-111102-1), samples M-124 and DUP-5 (from SDG 440-111886-1) and samples M-10 (from SDG 440-111887-1) and DUP-6 (from SDG 440-111886-1), samples DUP-6 (from SDG 440-111886-1) and M-10 (from SDG 440-111887-1), and samples M-12A and DUP-7 (from SDG 440-112107-1) were identified as field duplicates. No results were detected in any of the samples with the following exceptions:

XI. Sample Result Verification

All sample result verifications were acceptable with the following exceptions:

Raw data were not reviewed for Stage 2B validation.

XII. Overall Assessment of Data

The analysis was conducted within all specifications of the methods.

In the case where more than one result was reported for an individual sample, the least technically acceptable results were deemed unusable as follows:

Due to holding times exceedances, data was rejected in two samples.

Due to holding time exceedances, MS/MSD %R, and field duplicate difference, data were qualified as estimated in one hundred seventy-nine samples.

Due to equipment blank contamination, data were qualified as estimated in twenty-three samples.

The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be rejected (R) are unusable for all purposes. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the data validation all other results are considered valid and usable for all purposes.

2015 Annual Remedial Performance Sampling

Wet Chemistry - Data Qualification Summary - SDGs 440-98184-1, 440-99068-1, 440-99129-1, 440-100474-1, 440-101558-1, 440-101655-1, 440-101929-1, 440- 102243-1, 440-102526-1, 440-102689-1, 440-102831-1, 440-102951-1, 440-103031-1, 440-103261-1, 440-103265-1, 440-103983-1, 440-104247-1, 440-104381-1, 440- 106313-1, 440-106482-1, 440-107316-1, 440-107507-1, 440-107831-1, 440-108677-1, 440-108680-1, 440-108808-1, 440-108986-1, 440-109155-1, 440-109318-1, 440- 109936-1, 440-110425-1, 440-110520-1, 440-110604-1, 440-110670-1, 440-110673-1, 440-110832-1, 440-110834-1, 440-110915-1, 440-110962-1, 440-111099-1, 440- 111102-1, 440-111211-1, 440-111333-1, 440-111334-1, 440-111455-1, 440-111577-1, 440-111754-1, 440-111886-1, 440-111887-1, 440-112107-1, 440-112454-1, 440- 112626-1, 440-113481-1, 440-113571-1, 440-113703-1

2015 Annual Remedial Performance Sampling

Wet Chemistry - Laboratory Blank Data Qualification Summary - SDGs 440-98184- 1, 440-99068-1, 440-99129-1, 440-100474-1, 440-101558-1, 440-101655-1, 440- 101929-1, 440-102243-1, 440-102526-1, 440-102689-1, 440-102831-1, 440-102951-1, 440-103031-1, 440-103261-1, 440-103265-1, 440-103983-1, 440-104247-1, 440- 104381-1, 440-106313-1, 440-106482-1, 440-107316-1, 440-107507-1, 440-107831-1, 440-108677-1, 440-108680-1, 440-108808-1, 440-108986-1, 440-109155-1, 440- 109318-1, 440-109936-1, 440-110425-1, 440-110520-1, 440-110604-1, 440-110670-1, 440-110673-1, 440-110832-1, 440-110834-1, 440-110915-1, 440-110962-1, 440- 111099-1, 440-111102-1, 440-111211-1, 440-111333-1, 440-111334-1, 440-111455-1, 440-111577-1, 440-111754-1, 440-111886-1, 440-111887-1, 440-112107-1, 440- 112454-1, 440-112626-1, 440-113481-1, 440-113571-1, 440-113703-1

No Sample Data Qualified in these SDGs

2015 Annual Remedial Performance Sampling

Wet Chemistry - Field Blank Data Qualification Summary - SDGs 440-98184-1, 440- 99068-1, 440-99129-1, 440-100474-1, 440-101558-1, 440-101655-1, 440-101929-1, 440-102243-1, 440-102526-1, 440-102689-1, 440-102831-1, 440-102951-1, 440- 103031-1, 440-103261-1, 440-103265-1, 440-103983-1, 440-104247-1, 440-104381-1, 440-106313-1, 440-106482-1, 440-107316-1, 440-107507-1, 440-107831-1, 440- 108677-1, 440-108680-1, 440-108808-1, 440-108986-1, 440-109155-1, 440-109318-1, 440-109936-1, 440-110425-1, 440-110520-1, 440-110604-1, 440-110670-1, 440- 110673-1, 440-110832-1, 440-110834-1, 440-110915-1, 440-110962-1, 440-111099-1, 440-111102-1, 440-111211-1, 440-111333-1, 440-111334-1, 440-111455-1, 440- 111577-1, 440-111754-1, 440-111886-1, 440-111887-1, 440-112107-1, 440-112454-1, 440-112626-1, 440-113481-1, 440-113571-1, 440-113703-1

Annual Remedial Performance Report for Chromium and Perchlorate Nevada Environmental Response Trust Site Henderson, Nevada

APPENDIX E ELECTRONIC DATA DELIVERABLE (EDD)

Comments Regarding Appendix E:

There is no available well screen information in the January 2014 All Wells Database for following wells: H-28A, HM-2, HMW-13, HMW-14, HMW-15, HMW-16, MC-3, MC-6, and MC-7. The sample depth fields in the Electronic Data Deliverable (EDD) have been left blank and the sample_comment field notes: No screen information available. In future EDDs, the Trust will include sample depths for these wells when that information becomes available.

Annual Remedial Performance Report For Chromium and Perchlorate Nevada Environmental Response Trust Site Henderson, Nevada

> **ATTACHMENT A PHASE III GROUNDWATER MODEL REFINEMENT**

Prepared for **Nevada Environmental Response Trust**

Project Number **21-37300A**

Prepared by **Ramboll Environ Emeryville, California**

Date **October 31, 2015**

PHASE III GROUNDWATER MODEL REFINEMENT NEVADA ENVIRONMENTAL RESPONSE TRUST SITE HENDERSON, NEVADA

Date **October 31, 2015** Prepared by **Ramboll Environ** Description **DRAFT Phase III Groundwater Model Refinement**

Project No **21-37300A**

Ramboll Environ 2200 Powell Street Suite 700 Emeryville, CA 94608 USA T +1 510 655 7400 F +1 510 655 9517 www.ramboll-environ.com

CONTENTS

LIST OF TABLES

- Table 1b Revised Conceptual Water Balance Summary
- Table 2 Model Recharge Distribution
- Table 3 Groundwater Extraction Rates Second Quarter 2014
- Table 4 Model Layers
- Table 5 Modeled Water Balance
- Table 6 Calibration Statistics
- Table 7 Sensitivity Analysis of Model Conductivity Values

LIST OF FIGURES

- Figure 1 Phase III Model Extent
- Figure 2a Site Features
- Figure 2b Area of Phreatophytes Near Las Vegas Wash
- Figure 3 Model Recharge Zones
- Figure 4 Model Boundary Conditions
- Figure 5 Aquifer Test Results Near Paleochannels
- Figure 6a Model Hydraulic Conductivity
- Figure 6b Model Hydraulic Conductivity, Layer 1
- Figure 6c Model Hydraulic Conductivity, Layer 2
- Figure 7 Alluvium-UMCf Contact Elevation
- Figure 8 Extent of Shallow UMCf Coarse-Grained Unit #1
- Figure 9 Stream Conductance
- Figure 10 Stream Stage and Streambed Elevation of Las Vegas Wash

APPENDICES

- Appendix A1 Model Target Groundwater Elevations
- Appendix A2 Vertical Head Gradients (Second Quarter 2014)
- Appendix B Calibration Target Residuals
- Appendix C Model Files (Provided Electronically)

1. INTRODUCTION

On behalf of the Nevada Environmental Response Trust (the Trust), Ramboll Environ US Corporation (Ramboll Environ) has prepared this Phase III Groundwater Model Refinement report describing updates to the groundwater flow model (the "Phase III Model") for the Nevada Environmental Response Trust Site (the Site), located in Clark County, Nevada (Figure 1).

The Phase III Model is a refinement to the previous version of the model and was developed to support the optimization of the existing groundwater extraction and treatment system (GWETS) under the 2015 Continuous Optimization Program (COP) and to support the calculation of GWETS performance metrics provided in semi-annual and annual performance reports. The performance metrics were described in the 2013 GWETS Optimization Project Work Plan (ENVIRON 2013), approved by the Nevada Division of Environmental Protection (NDEP) on December 3, 2013 (NDEP 2013). The Phase III Model will be refined further to support the Remedial Investigation and Feasibility Study (RI/FS), as described in the RI/FS Work Plan (ENVIRON 2014b). As part of the RI/FS modeling work, a comprehensive model documentation report will be developed.

Throughout the remainder of this report the Phase III Model will be referred to simply as "the model", except where there is a need to differentiate between the various versions. Figure 1 depicts the current extent of the model.

1.1 Previous Model Versions

The initial version of the groundwater model for the Site was developed by Northgate Environmental Management Inc. (Northgate) and was approved on April 4, 2013 by NDEP for use in capture zone evaluation. This model, referred to as the "Northgate Model", is a steady-state flow model calibrated to Site conditions in 2008/2009, as documented in the Capture Zone Evaluation Report (Northgate 2010). Refinements to the steady-state model are being implemented by Ramboll Environ in phases.

The Phase I Model was documented in an attachment to the 2013 Semi-Annual Remedial Performance Report for Perchlorate and Chromium (ENVIRON 2014a). The first phase of model refinements included: 1) an update of the model to reflect current pumping and injection rates of the GWETS, as well as remediation systems of American Pacific Corporation (AMPAC) and Olin/ Stauffer/Syngenta/Montrose (OSSM); and 2) preliminary refinement of the model representation of stream-aquifer interaction near Las Vegas Wash. The model report included a conceptual water budget for the model area. The Phase I Model was used to support the calculation of GWETS performance metrics presented in the 2013 Semi-Annual Report.

The Phase II Model was documented in an attachment to the 2014 Annual Performance Report (ENVIRON 2014c). The second phase of model refinements included: 1) revision of model hydraulic conductivities to incorporate recent aquifer testing results, and 2) further refinements to the representation of stream-aquifer interactions at Las Vegas Wash. The conceptual water balance was also refined in the Phase II Model report to incorporate additional information and updates to the conceptual model.

1.2 Phase III Model Refinements

The third phase of model refinements are summarized in this section and described in more detail in the remainder of this report. The Phase III Model incorporates the detailed evaluation of subsurface conditions and hydrogeology in the area downgradient of the NERT Site conducted as part of the 2015 COP. This detailed evaluation included a refined interpretation of the contact between the alluvium and the Upper Muddy Creek formation (UMCf) and a summary of aquifer testing results. In addition, the Phase III Model refinements address most of the NDEP comments on the Phase II Model received via email.

Phase III Model refinements include the following:

- The model boundary has been extended to the north and east to include inflow from the east and northern mountain front recharge.
- The stream boundary has been revised to better represent the current width and streamflow of Las Vegas Wash.
- Alluvium thickness has been refined in the area from the northern NERT Site boundary to Las Vegas Wash.
- The conceptual water balance has been updated based on site conditions existing in second quarter 2014. The flows simulated in the groundwater model have been adjusted to match the conceptual water budget.
- Areal recharge rates (including rainfall recharge) have been re-evaluated and refined.
- The model has been refined near the AMPAC site to better simulate the influence of AMPAC's groundwater extraction system.
- The newly installed Titanium Metals Corporation (TIMET) extraction well field and barrier wall have been added to the model. All flow barriers used in the model are described in this report.
- Groundwater inflows and outflows across the model boundaries have been refined and further documented.
- The hydraulic conductivity distribution has been updated to incorporate additional aquifer testing data.
- The groundwater model has been re-calibrated to match water level targets from the second quarter of 2014.
- The model representation of evapotranspiration has been updated to incorporate the distribution of phreatophytes mapped using 2014 aerial imagery.
- An initial contaminant transport model has been developed to facilitate the calculation of GWETS metrics for mass flux, which is documented in the GWETS Annual Report.

The following refinements to the model requested by NDEP will be implemented as part of the model development to support of RI/FS.

- The weirs installed in Las Vegas Wash will be explicitly modeled.
- A more comprehensive uncertainty analysis will be conducted.
- The model boundary will be extended to Three Kids Weir and the influence of fault zones in that area will be evaluated.

2. REVISED CONCEPTUAL WATER BALANCE

A conceptual water balance was developed to provide an independent evaluation of the inflows and outflows of groundwater within the model domain that can be used to guide model refinement. The Phase III groundwater model represents the approximately steady-state period in second quarter 2014. The conceptual water balance presented in the Phase II Model report has been updated to account for the change in the extent of the model domain and to reflect refinements in estimates of water balance components. Horizontally, the model domain of the Phase III model has increased by about 4,200 acres as compared to the Phase II model. Vertically, the model domain is unchanged and includes the Shallow and Middle Water Bearing Zones (WBZs), but does not include deeper portions of the Upper Muddy Creek Formation (UMCf). The revised conceptual water balance is presented in Tables 1a and 1b. The methods and data sources for individual water balance components that have been revised are described in the following sub-sections.

2.1 Groundwater Outflows

The major groundwater outflow components in the model area are groundwater extraction, groundwater discharge to Las Vegas Wash, eastern boundary outflow below Las Vegas Wash, and evapotranspiration from shallow groundwater.

2.1.1 Groundwater Extraction

Groundwater pumping in second quarter 2014 was conducted at extraction systems associated with four facilities within the model area: NERT, OSSM, TIMET, and AMPAC. NERT operates three well fields, including the Interceptor Well Field (IWF), the Athens Road Well Field (AWF), and the Seep Well Field (SWF). AMPAC operates three well fields, including the Athens Road Extraction Wells (AREWs), Athens Pen Extraction Wells (APEWs), and Auto Mall Extraction Wells (AMEWs). Extraction well fields are shown in Figure 2a.

Total groundwater pumping at these sites was aggregated from available data for second quarter 2014. At the NERT Site, the average pumping rates for second quarter 2014 for the IWF, AWF and SWF were 74 gallons per minute (gpm) (14,279 cubic feet per day [cfd]), 282 gpm (54,346 cfd), and 488 gpm (94,056 cfd), respectively (ENVIRON 2014c). The combined average pumping rate for this time period was 147 gpm (28,301 cfd) for the OSSM system (de maximis 2014b), 25.5 gpm (4,914 cfd) for the TIMET system (TIMET 2014), and 673 gpm (129,739 cfd) for the AMPAC system (AMPAC 2014). The TIMET well field and the AMPAC AMEWs were not represented in previous versions of the model.

2.1.2 Groundwater Discharge to Las Vegas Wash

Since the rate of groundwater discharge to the Las Vegas Wash cannot be directly measured, this quantity was indirectly estimated by comparing measured sources of inflows and outfalls along the reach of the Las Vegas Wash that forms the northern model boundary. The data compiled for this estimate includes streamflow data from United States Geological Survey (USGS) gauging stations; City of Henderson (COH) treated wastewater outflows; and treated effluent discharge rates from the NERT, TIMET, and AMPAC sites. These data are presented in Table 1a and the locations of USGS stream gauges and outfalls are shown in Figure 2a. The method used to estimate this discharge remains the same as described in the Phase I and Phase II Model reports (ENVIRON 2014a, ENVIRON 2014c), and is summarized as follows.

For this analysis, the reach of Las Vegas Wash adjoining the model domain was divided into two sub-reaches bounded by USGS stream gauges. Reach A extends from the Las Vegas Wasteway Gauge (#09419679) to the Pabco Road Gauge (#09419700), and includes a tributary of Las Vegas Wash (Duck Creek, #09419696) and inflows from several wastewater outfalls. Reach B extends from the Pabco Road Gauge to the Three Kids Gauge (#09419753), and includes a storm water channel (C-1) that had no flow during the water balance period.

Conceptually, the calculation performed for each sub-reach involved summing all known inflows and outflows of surface water. After performing the summation, any missing flow was assumed to originate from groundwater discharges along the length of the sub-reach. This calculation did not separately estimate potential seepage from Las Vegas Wash due to pumping at the Seep Well Field (SWF), instead presenting overall groundwater discharge to Las Vegas Wash as a net outflow.

Calculation of Average Streamflow by Gauge

The daily streamflow data from the second quarter of 2014 were downloaded from the USGS website¹ for the above mentioned stream gauge stations. Since the purpose of the water balance analysis is to estimate groundwater inflow, the streamflow data was adjusted to remove flow measurements affected by rainfall events prior to calculating the overall average flow for the water balance period. To identify streamflow measurements affected by rainfall, historical stream gauge and rainfall data² from 2012 to 2014 were evaluated to determine how rainfall is correlated with changes in streamflow. By plotting daily streamflow against total rainfall over the prior two days, it was observed that rainfall events with more than 15 mm accumulation over 2 days produced a significant rise in streamflow over the baseline values. Streamflow values affected by rainfall were excluded when computing the average streamflow by station. The resulting average values are shown in the water balance calculations for each reach in Table 1a.

Calculation of Surface Water Lost to Evaporation

The portion of the streamflow in Las Vegas Wash lost to evaporation was estimated from the area of Las Vegas Wash and literature values of evaporation rates. The surface area of Las Vegas Wash (including Duck Creek) between the Las Vegas Wasteway and Three Kids gauging stations was estimated from an aerial photo as 450 acres. Available daily evaporation data from 1997-1999 for four stations located in or near Lake Mead indicate an average evaporation rate of 81 inches per year (Westenburg et al. 2006).³ Multiplying the area of Las Vegas Wash by the evaporation rate results in an estimated 4.2 cfs of surface water evaporated from Las Vegas Wash within this area. This value was allocated to Reaches A and B based on the relative area of each reach, resulting in outflows of 2.5 and 1.7 cfs.

Estimation of Groundwater Discharge to Reach A

The surface inflows to Reach A are listed in Calculation A on Table 1a. These inflows, which total 293 cfs, include average flows measured at USGS stream gauges (calculated using the previously mentioned procedure), and average flows recorded at treated wastewater outfalls. The COH wastewater outfall reportedly discharged 19.7 cfs to Las Vegas Wash during second

ł

¹ Data downloaded from<http://waterdata.usgs.gov/usa/nwis/sw> on March 3, 2015.

² Data measured daily at McCarran Airport.

³ Evaporation rates for second quarter 2014 were not available, but are not expected to be significantly different than those from 1997-1999.

quarter 2014.⁴ The AMPAC outfall location is very close to the NERT Site discharge location and reportedly produces effluent at a rate roughly equal to the combined extraction rates from the AMPAC wells.⁵ The average NERT Site, AMPAC, and TIMET discharges outfall to Las Vegas Wash were reported as 2.0 cfs, 6 1.4 cfs, and 6.1 cfs⁵ in second quarter 2014, respectively.

The surface water outflows from Reach A, which total 296.9 cfs, include evaporation (calculated using the previously mentioned procedure) and measured flow at the Pabco Road Gauge. The difference between these total inflows and outflows, 4.0 cfs, is attributed to net groundwater discharge to Reach A.

Estimation of Groundwater Discharge to Reach B

As illustrated in Calculation B on Table 1a, surface inflow to Reach B is estimated as the average measured flow at the Pabco Road Gauge (294.4 cfs). Outflows from Reach B consist of evaporation and average measured flow at the Three Kids Gauge, totaling 297.5 cfs. The difference between these total inflows and outflows, 3.1 cfs, is attributed to groundwater discharge to Reach B.

Estimation of Groundwater Discharge to Las Vegas Wash in the Conceptual Model Domain

For the purposes of the water balance, the groundwater discharges to Reaches A and B required adjustment to exclude groundwater flow outside the model domain. This was done based on the linear extent of each Reach within the model domain. For Reach A, it was estimated that 71% of the estimated discharge to the Wash (2.8 cfs) was within the model domain. For Reach B, it was estimated that 49% of the estimated discharge to the Wash (1.5 cfs) was within the model domain. The total groundwater discharge to the Wash of 4.4 cfs (370,000 cfd) was applied to the overall conceptual water balance.

2.1.3 Evapotranspiration From Groundwater

Evapotranspiration from shallow groundwater may occur in the areas of phreatophytic vegetation found along the Las Vegas Wash. In the Las Vegas Valley, these plant species include salt grass, mesquite, tule, marsh grass, cottonwood, and willow (USGS 1996). Near the Wash, the main phreatophyte is saltcedar (BRC 2010).

To estimate the site-specific evapotranspiration rate, reference evapotranspiration rates were applied to a recent estimate of the phreatophytic vegetation coverage area. The area of vegetation coverage has varied over time due to construction activities near the Wash. To represent the water balance period, the extent of phreatophytic vegetation was digitized in GIS from an aerial photograph dated March 2014, 7 resulting in a total area of approximately 240 acres (Figure 2b). Reference evapotranspiration rates for the Las Vegas Valley have been reported ranging from 3.9 to 5.2 feet per year for pasture grass. 8 As in previous versions of the conceptual water balance, a potential evapotranspiration rate of approximately 4 feet per year was used. Applying this rate to the phreatophytic vegetation extent shown in Figure 2b results in maximum potential evaporation rate of 115,000 cfd. This represents the maximum value because it assumes that the area is completely covered with phreatophytes and that the water

ł

⁴ Per data received via email from Howard Analla of the COH, dated 7/09/2013.

⁵ Per email communication with Gary Carter of AMPAC, dated 9/10/2013.

⁶ NERT Effluent Records, NPDES Permit number – NV0023060.

⁵ Per data received via email from Sylvia Dahl of NDEP, dated 6/6/2014.

⁷ Received from SNWA via mail on 08/26/2015

⁸ http://water.nv.gov/mapping/et/et_general.cfm, downloaded on 04/9/2015

table is always within the root zone. In Table 1b, this maximum value was reduced by 85% to account for the portion of phreatophytic vegetation areas with a water table below the root zone and the sparseness of vegetation in much of the area.

2.2 Groundwater Inflows

The major groundwater inflow components in the model domain are areal recharge, focused recharge from surface water bodies, mountain block recharge from the northern and southern boundaries of the model, western boundary inflows, and vertical inflow from the deep UMCf. These components have been revised for both the conceptual water balance and the Phase III Model as described below and shown in Table 1b.

2.2.1 Areal Recharge

Potential sources of areal recharge identified within the model domain include rainfall infiltration, and recharge associated with residential, industrial, and irrigated land uses.

Precipitation Recharge

Rainfall infiltration was evaluated as a potential source groundwater inflow in the conceptual water balance. The average precipitation rate for the period 1980-2014 near the site is approximately 5 inches per year. 9 Historical recharge estimation studies for the Nevada groundwater basins suggested that precipitation recharge is negligible in basins experiencing less than 8 inches of precipitation per year (Maxey and Eakin 1949). The USGS regional study for the Las Vegas valley (USGS 1996) indicates that precipitation recharge is negligible in the valley, consistent with the findings reported by Maxey and Eakin. Based on an empirical relationship between evapotranspiration and rainfall, given the site climate and under bare land cover the precipitation recharge was estimated as negligible (Sanford and Selnick 2013). Hence, precipitation recharge in undeveloped areas was excluded from both the conceptual water balance and the Phase III Model.

Residential Areas

Groundwater recharge in residential areas was assumed to originate from municipal water supply lost to groundwater through leaky distribution pipelines. This value was estimated using water supply data provided by COH.¹⁰ For 2014, the total water supplied to COH was 25 million gallons. Out of the total supplied water about 3 percent (1 million gallons) remain unaccounted for. For the recharge estimations, the annual estimate of unaccounted water was distributed over the total COH area of 107 square miles, 11 resulting in a recharge rate of approximately 9.2 X 10⁻⁵ feet per day. The total residential area within the model domain is about 14 square miles or 3.93 \times 10⁸ square feet, which results into the total recharge flow to the model domain of 36,000 cubic feet per day. Additional recharge from irrigation of residential landscaping is assumed to be negligible compared to the rate from leakage.

Industrial Areas

ł

The groundwater recharge rate for industrial areas was estimated using a similar approach as for the residential areas. The water supply data used were annual raw water delivery and wastewater generation totals for the BMI complex between 2011 and 2013. The total water

⁹ Based on climate data produced by Oregon State University's PRISM Climate Group (PRISM 2013).

¹⁰ As per telephone communication with Tim Kelly at the COH Water Reclamation Facility on May 13, 2015.

¹¹ http://www.cityofhenderson.com/

supplied to the BMI complex during this period was approximately 5,413 acre feet per year.¹² Out of this, approximately 65 acre feet per year were returned as wastewater. Hence, about 5,348 acre feet per year of water was used in the complex. The total area of BMI complex is about 5,000 acres.¹³ Assuming that 25% of water used in the complex is lost to leakage from underground distribution pipelines (Lerner 2002), the groundwater recharge rate from industrial areas within model domain would be approximately 7.3×10^{-4} feet per day. If we assume that industrial water use in the model area is similar to that at the BMI complex, applying this rate to the total industrial area (4.2 \times 10⁷ square feet) results in an estimated total recharge flow of 30,786 cubic feet per day.

Golf Course Irrigation

The Chimera Golf Club course in the Tuscany Village development area has an irrigated area of 128 acres within the model domain. Typically, excess irrigation water is applied to turf grass to prevent salt build-up in the root zone. The amount of turf irrigation water that recharges groundwater can generally be estimated as 25 percent of the annual consumptive use (BRC 2008). The Clark County Area Wide Water Quality Management Plan for 2009 reported the total water usage by the golf course as 674 acre feet per year.¹⁴ Based on these values, an average recharge rate of 1.78×10^{-3} feet per day has been estimated for the golf course area. This corresponds to a total recharge flow of approximately 10,000 cubic feet per day.

The distribution of areal recharge rates is shown on Figure 3. The recharge flows to groundwater are presented in Table 2.

2.2.2 Focused Recharge

Focused recharge from several surface water features in the model domain were evaluated separately and incorporated into the water balance and the Phase III Model.

Bird Viewing Preserve

A significant source of surficial recharge to groundwater is a series of unlined ponds operated by COH as a bird viewing preserve. An average of 1.21 MGD of inflow to the ponds was recorded by COH for second quarter 2014. The ponds have an area of approximately 110 acres. Assuming COH is maintaining a relatively constant level of surface water in the ponds, and using average evaporation rate of 81 inches per year, 15 the recharge from the ponds to the shallow groundwater aquifer was estimated to be 0.015 feet per day. Since the water-filled area of the ponds is about 2.68 \times 10⁶ square feet, the total volumetric recharge rate for the ponds was estimated to be approximately 40,000 cfd.

Ponds and Trenches

ł

The OSSM and TIMET sites operate infiltration trenches just downgradient of their extraction wells for disposal of treated groundwater (Figure 3). Based on the OSSM second quarter 2014 monitoring report, an average of 147 gpm (28,000 cfd) of water was discharged to the trenches (Hargis and Associates 2014). This flow was applied as a recharge zone in the model with a recharge rate of 0.21 ft/day. The total discharge to the TIMET trenches for second quarter 2014

¹² Received from Weiquan Dong of NDEP via email on 05/15/2014.

¹³ http://www.ndep.nv.gov/bmi/index.htm

¹⁴ http://www.clarkcountynv.gov/blob/public_communications/120709_WQMP_FINAL_REVISED.pdf

¹⁵ Data received from Michael T. Moreo of USGS via email on 09/03/2013.

was reported as 25.5 gpm (4,900 cfd) (GEI 2014b). This discharge was applied in the model as a recharge zone with a recharge rate of 0.053 ft/day (Figure 3).

Other historical sources of focused recharge, including the NERT former on-site recharge trenches, former COH Rapid Infiltration Basins (RIBs), BMI Pond, TIMET Pond, and the AMPAC reinjection system were not active during the Phase III Model period and are not considered in the water balance.

Storm Water Retention Basins

There are two storm water retention basins at the NERT Site covering an area of 7.8 \times 10⁵ square feet (Figure 3). According to a surface infiltration modelling study performed in a semiarid area in New Mexico, approximately 30 to 50 percent of storm water routed to retention basins in semi-arid areas is expected to ultimately recharge groundwater (Miller 2006). Assuming 50 percent of rainfall recharges groundwater and an average historical rainfall of 5 inches per year at the site (PRISM 2013), recharge from storm water retention basins is estimated to be 5.7×10^{-4} ft/day. This corresponds to an inflow to groundwater of 320 cfd.

The recharge rates and volumetric flows from surface water bodies are presented in Table 2 and are shown on Figure 3.

2.2.3 Lateral and Vertical Boundary Inflows and Outflows

Groundwater flows across the lateral and bottom model boundary are the primary sources of inflow to the model domain. These values are difficult to estimate with certainty since there is little site characterization available at the edges of the model domain. The boundary inflows have been subdivided into lateral inflows from the southern and northern boundaries, lateral inflows from the west below Las Vegas Wash, and vertical inflows from the deep UMCf. These inflows were estimated separately, as described below:

Southern Boundary Inflow

The alluvium is presumed to be either unsaturated or not present at the southern lateral boundary. Thus, groundwater inflow through the southern boundary was assumed to occur primarily through the UMCf. The southern boundary inflow was estimated using measured hydraulic conductivity values for the UMCf and the head gradient at the southern boundary of the Site. Within the model domain, the UMCf consists of distinct interbedded units composed of either coarse-grained sediments (UMCf-cg) or fine-grained sediments (UMCf-fg) (ENVIRON 2014a). The cross-section on Plate 6 of the RI/FS workplan for the NERT Site (ENVIRON 2014b) depicts the coarse-grained UMCf as present in two distinct intervals separated by UMCf-fg. The shallower coarse grained unit is termed the UMCf-cg1 and deeper unit UMCf-cg2. The coarse grained unit is also described in AMPAC's 2013 transient groundwater modeling report (Geosyntec 2013).

Based on the depiction of the saturated portion of the UMCf-fg and UMCf-cg in cross-section (Plate 6 of Geosyntec 2013), 25% of the southern boundary thickness was allocated to the UMCf-fg, and 75% was allocated to the UMCf-cg. The horizontal hydraulic conductivity of the UMCf used in the Phase III Model (0.72 ft/day) was applied to the UMCf-fg, and the hydraulic conductivity of the UMCf-cg (8 ft/day) obtained from the AMPAC model (Geosyntec 2013) was applied to the UMCf-cg. The horizontal head gradient measured upgradient of the NERT Site boundary during second quarter 2014 was about 0.0077 ft/ft (ENVIRON 2014a). The southern model boundary is 45,000 feet in length and the thickness of UMCf is 250 feet in the model. Using these values, an inflow of 210,000 cfd was estimated for the southern boundary.

Northern Boundary Inflow

The northern model boundary has been extended into the alluvial fan north of Las Vegas Wash in the Phase III Model. The area north of the Wash consists mainly of outcrops of steep, older volcanic rock and hence minimal groundwater flow is expected through this boundary from the adjacent watershed. Most of the rainfall falling north of the Wash would be expected to either evaporate or flow as run-off into Las Vegas Wash. There is little information currently available to estimate this inflow. Thus, groundwater inflow across the northern boundary was treated as an unknown, and estimated as the amount of groundwater inflow required to make up the difference when matching overall groundwater inflows to outflows in the final water balance. This resulted in an estimate of 3,700 cfd groundwater inflow through the northern model boundary.

Eastern and Western Boundary Underflow

Since the model area is oriented along the general direction of groundwater flow, net inflows and/or outflows of groundwater along the eastern and western lateral boundaries of the conceptual water balance area are expected to be minimal. However, in the vicinity of Las Vegas Wash, we expect groundwater underflow where Las Vegas Wash enters the model area on the western boundary and where it exits the model area on the eastern boundary. Approximate values for these underflows were obtained with Darcy's Law by roughly estimating the width and depth of saturated alluvium, the hydraulic gradient, and hydraulic conductivity at the model area boundaries.

The calculation for the western boundary inflow assumes the saturated alluvium to be 4,200 feet wide. This value is the estimated extent of the western model boundary where a significant lateral flow component would be expected from the adjacent watershed. This area was assumed to be 50 feet thick, with a hydraulic conductivity value of 300 ft/day obtained from the calibrated Phase III groundwater model. The calculation for the eastern boundary outflow assumed the saturated alluvium to be 750 feet wide and 50 feet deep, with a hydraulic conductivity of 600 ft/day. A hydraulic gradient of 0.005 ft/ft was assumed at both ends of the Wash based on the stream bed profile for Las Vegas Wash obtained from the Federal Emergency Management Agency (FEMA) flood insurance study for Clark County (FEMA 2011). Based on these values, the groundwater inflow from the western boundary was estimated to be 320,000 cfd, and the outflow at the eastern boundary was estimated to be 110,000 cfd.

Vertical Boundary Inflow

The vertical boundary inflow consists of upwards flow from the deeper portion of the UMCf in the Deep WBZ. The average vertical head gradient between pairs of wells in the IWF and the AWF was approximately 0.09 ft/ft for second quarter 2014. The well pairs used for this purpose are M-71/M-163, M-74/M-165, PC-135A/PC-134A, and PC-136/PC-137. The vertical gradient for different well pairs measured in second quarter 2014 are shown in Appendix A2. It was assumed that vertical inflow is present in all areas of the model with the exception of the Bird Viewing Pond and areas around the upgradient boundary of the model domain where the upper coarse grained UMCf is present, as shown on Figure 4. Using the measured vertical gradient, the total surface area of the model, and a representative UMCf vertical conductivity of 2.5 X 10⁻³ ft/day, the total vertical inflow to the model domain was estimated as 141,000 cfd. The vertical

conductivity value is derived from the average vertical conductivity of the bottom model layer in the calibrated Phase III groundwater model.

3. PHASE III GROUNDWATER MODEL UPDATE

The results of the revised conceptual water balance (Section 2) were used to guide the development of the Phase III Model. The key model components that have been revised from the Phase II Model are described in the following sections.

3.1 Model Extent

The model extent was expanded to coincide better with natural geologic and hydrogeological flow boundaries. The model boundary has also been extended to the north to simulate groundwater inflow through the alluvium north of the Wash. The revised model boundary is shown in Figure 1 with arrows indicating the typical direction of natural groundwater flow overlaying the regional geology.

3.2 Grid Refinement

The Phase III Model incorporates changes to both the model grid and layer elevations. The extent of the model grid with refined grid spacing (50 ft cells) has been extended in the off-site area north of the NERT site to support future transport modelling. The grid has also been refined (50 ft cells) near Las Vegas Wash to better represent the stream-aquifer interaction.

The contact elevation between the alluvium and UMCf was refined to incorporate the updated interpretation of stratigraphic features in the NERT downgradient plume area prepared as part of Task 2 of the COP. The revised contact elevation surface is shown in Figure 7. Layer 1 of the Phase II Model extended from the ground surface to the base of the alluvium. In the Phase III Model, the base of Layer 1 has been revised to incorporate both the alluvium and the upper coarse-grained UMCf unit (UMCf-cg1). The extent of the UMCf-cg1 was obtained by interpolating between cross-sections developed for the NERT, AMPAC, OSSM and TIMET sites.¹⁶ Layer 2 from the Phase II Model the UMCf has been split into three layers in the Phase III Model to better simulate contaminant transport in the upper portion of the UMCf. The revised model layer thicknesses are shown in Table 4.

3.3 Hydraulic Properties

The hydraulic conductivity distributions were revised in the Phase III Model to incorporate findings from the Task 3 Hydrogeologic Evaluation performed as part of the COPThe spatial distributions of horizontal hydraulic conductivity values in Layers 1 through 7 are shown on Figures 6a-6c.

3.3.1 Horizontal Hydraulic Conductivity

The following changes have been made to the hydraulic conductivity zones in Layer 1 (Figure 6b):

- The hydraulic conductivity of the paleochannels in the Phase III Model was revised to be consistent with the conceptual water balance and available aquifer testing estimates shown on Figure 10.
- The hydraulic conductivity within the paleochannels near the AWF was increased from 200 ft/day to 300 ft/day based on the average pumping test results from ART-2 (280 ft/day), PC-98 (334 ft/day; 290 ft/day), ART-7 (260 ft/day), and PC-100 (334 ft/day).

ł

¹⁶ Cross section references are listed on Figure 8.

- The hydraulic conductivity within the paleochannel near the SWF was further increased to 485 ft/day based on the nearby pumping test results.
- The horizontal hydraulic conductivity value for the remainder of the alluvium was increased from 35 feet/day to 40 feet per day to improve the model calibration.
- The conductivity values in the upgradient area of Layer 1, which now includes the UMCf-cg1, were modified to include conductivity values typical of the coarse grained unit. A range values between 6 ft/day and 10 ft/day was assigned, depending on the relative thickness of UMCf-cg1. The conductivity values were adjusted during calibration.

The horizontal hydraulic conductivity value applied to the deeper layers representing the UMCf-fg remains unchanged from the Phase II Model, with the exception of a small increase in Layer 2 conductivity from 0.7 to 2 ft/day to improve calibration and to represent a transitional UMCf below the alluvium (Figure 6c). Zones of higher conductivity in Layer 2 were defined around the shallow AMPAC pumping wells (40 ft/day) and the OSSM pumping wells (6 ft/day) in order to allow the model to accurately simulate the measured extraction rates. The spatial distribution of UMCf-cg, in particular the extent of the deeper UMCf-cg2 and the distribution of conductivity around the OSSM and AMPAC wells, will be further modified in the RI phase of the model development.

3.3.2 Vertical Hydraulic Conductivity

The vertical hydraulic conductivity values have been revised in the Phase III Model to be more consistent with measured values. Based on the aquifer testing data reviewed as part of the COP Task 3 Hydrogeologic Evaluation, vertical conductivity values in the alluvium were identified ranging from 0.02 ft/day to 4.2 ft/day. The vertical conductivity of alluvium in the model was reduced from 8.3 ft/day to 1 ft/day to be more characteristic of this range. For the UMCf, the range of reported vertical conductivity values was identified ranging from 4.3×10^{-7} ft/day to 0.2 ft/day. The vertical conductivity value of UMCf was revised throughout most of the model domain from 0.004 ft/day to 0.003125 ft/day. The vertical conductivity of the UMCf underneath the shallow AMPAC wells was increased to 0.0325 ft/day in order to allow the model to accurately simulate the measured extraction rates at these wells. As stated above, the distribution of the conductivity in the vicinity of the AMPAC wells will be further refined in the RI phase of model development.

3.3.3 Hydraulic Flow Barriers

The slurry wall located on the NERT Site, immediately north of the IWF, is simulated as a hydraulic flow barrier (HFB). The reported range of conductivities used during construction was 4.7×10^{-8} centimeters per second (cm/sec) to 8.0×10^{-7} cm/sec (Vector 2001). This range is similar to the average hydraulic conductivity measured by permeability testing of the barrier wall at four locations of 8.8×10^{-7} cm/sec, as reported in the Capture Zone Evaluation Report (Northgate 2010). For modeling purposes, the value of 8.8×10^{-7} cm/sec was used to represent the barrier wall's hydraulic conductivity. According to the conceptual site model developed by ENSR International Corporation (ENSR), the slurry wall is about 1,600 feet long, 3 feet thick, and 60 feet deep, and was constructed to tie into approximately 30 feet of UMCf (ENSR 2005). The layer thicknesses were adjusted in the Phase III Model to more accurately represent the slurry wall configuration.

The TIMET barrier/slurry wall was completed in early 2014. This barrier wall is represented in the Phase III Model as a hydraulic flow barrier, the same approach used for the NERT Site barrier. Based on the construction report (GEI 2014a), the slurry wall was represented in the model

using a hydraulic conductivity of $1x10^{-6}$ cm/sec, a total length of 2,410 feet, and a depth of 60 feet. The thickness of the wall was assumed to be 3 feet.

3.4 Boundary Conditions

The model boundary conditions include lateral flows of groundwater through the model boundary, vertical inflow from the base of the model, the stream boundary representing Las Vegas Wash, evapotranspiration, pumping/injection from wells, and areal and focused recharge. Boundary conditions modified for the Phase III Model are described in the following sections.

3.4.1 Lateral Boundary Inflows and Outflows

The southern boundary inflow in the Phase III Model was simulated using a specified flow boundary condition. The fluxes of the boundary cells was adjusted until the total inflow through the boundary approximately matched the value derived for the conceptual water balance. The overall simulated inflow through the upgradient boundary has increased from 90,000 cfd in the Phase II Model to 210,000 cfd, mainly due to the larger extent of the southern boundary (Table 5).

As described in Section 2.2.3, groundwater inflows and outflows are expected in the aquifer underlying Las Vegas Wash. Specified flow boundary cells were assigned in Layer 1 where the model boundary crosses Las Vegas Wash to simulate groundwater inflow through the western boundary (Figure 6). Similarly, specified flow cells were assigned along the eastern boundary at the downstream end of the Las Vegas Wash. The total inflow and outflow simulated from the new specified flow boundaries in the Phase III Model are approximately 300,00 cfd and 130,000 cfd, respectively (Table 5). These boundary flows may be adjusted further as part of the RI.

The northern model boundary has been extended into the alluvial fan north of Las Vegas Wash in the Phase III Model. The procedure for estimating the groundwater inflow from this boundary (7,400 cfd) was described in Section 2.2.3. The northern inflow was applied to the model by distributing the inflow to a series of wells located in each of the cells along the northern boundary in Layers 1 and 2.

3.4.2 Vertical Inflow

The conceptual water balance estimated a total upwards vertical flow into the model domain of 141,000 cfd. This vertical inflow was presumed to be present in all areas of the model with the exception of the Bird Viewing Pond and areas near the upgradient boundary of the model domain where the upper coarse grained UMCf is present. This spatial distribution of vertical flow was implemented in the Phase III Model through the use of GHB cells placed in the northern half of the model domain in Layer 7 (Figure 4). These cells were assigned head values equal to interpolated head values available for UMCf at head gradient targets (Appendix A2). The resulting simulated total upwards flow was 160,000 cfd. Future work as part of the RI phase of model development may include refining the vertical inflow to match head gradient targets derived from well clusters throughout the model extent.

3.4.3 Stream Boundary

The stream boundary was updated in the Phase III Model in order to better simulate stream/aquifer interactions at Las Vegas Wash. As shown in Figure 9, the overall extent of the stream is the same as in the Phase II Model, and includes flows from Duck Creek, a small tributary stream carrying surface water discharges near Pabco Road, and the C-1 Channel. The surface water inflows entering each stream reach were estimated from various measured sources of discharge to Las Vegas Wash, including streamflow data from USGS gauging stations, COH treated wastewater outflows and effluent discharge rates from the Site, AMPAC, and TIMET outfalls (see Section 2.1.2 and Table 1a). These values were assigned as inputs to the Phase III Model for calibrating the stream package. The stream was divided into segments so that the model can be used to tabulate the simulated stream flow at Pabco Road and the eastern model boundary. The segments are not meant to represent the actual flows within Las Vegas Wash; they are only to allow the tabulation of total flows at stream gauges. The Phase III Model simulates stream flow of approximately 295 cfs near the Pabco Road gauging station, which (after correction for evaporation from the stream) generally matches the average recorded flow at this gauge.

Inputs to the stream package include the stream stage, the streambed elevation, and the hydraulic conductivity of the streambed. The streambed conductance is a function of area of the stream in each grid cell, the thickness of the streambed and the hydraulic conductivity of the streambed. The streambed conductance is shown in Figure 9. The areal extent of the stream in each stream grid cell was allocated based on 2014 aerial imagery obtained from the Southern Nevada Water Authority. The streambed thickness was set uniformly to 1 ft, and the conductivity was manually adjusted until the groundwater inflow to each stream segment matched approximately to the net groundwater inflow as described in Table 1a. The stream stage and streambed elevation profile are shown in Figure 10.

3.4.4 Evapotranspiration From Groundwater

The Phase II Model incorporated evapotranspiration by phreatophytes located along the Las Vegas Wash. This region was refined in the Phase III Model by digitizing areas of vegetation visible in satellite imagery from March 2014. The resulting zones of evapotranspiration are shown on Figure 9. The reference evapotranspiration for the Las Vegas Valley has been reported as ranging from 3.9 to 5.2 ft/year for pasture grass.¹⁷ However, evapotranspiration from the water table ceases at the extinction depth, the depth to which the roots of plants extend below the land surface. The roots for salt cedar may penetrate soil from 5 feet to 30 feet below ground surface depending on the density of growth.¹⁸ An extinction depth of 5 feet and an evapotranspiration rate of 4 feet per year are simulated in Phase III Model, as was previously done in the Phase II model. The simulated evapotranspiration rate from the calibrated model is approximately 8,800 cfd (Table 5). This does not include evaporation from surface water bodies, such as Las Vegas Wash and the Bird Viewing Pond, which are accounted for outside of the groundwater model.

3.4.5 Groundwater Pumping and Injection

The model has been updated to simulate pumping with the average rates from second quarter 2014. These pumping rates are presented in Table 3.

3.4.6 Areal and Focused Recharge

ł

Areal and focused recharge in the Phase III Model has been updated as described in the conceptual water balance in Sections 2.2.1 and 2.2.2.

¹⁷ http://water.nv.gov/mapping/et/et_general.cfm, downloaded on 04/9/2015

¹⁸ http://www.columbia.edu/itc/cerc/danoff-burg/invasion_bio/inv_spp_summ/Tamarix_ramosissima.html, downloaded 04/9/2015

4. MODEL CALIBRATION

The Phase III model was calibrated by varying model parameters so that the simulated model results are consistent with observation data, the conceptual water balance, and the overall conceptual model of groundwater flow in the model area. This section describes the model calibration process and evaluates the quality of model calibration.

4.1 Model Calibration Targets

During model calibration, model parameters were adjusted so that the simulated water levels were as close as possible to actual water levels measured in second quarter 2014. The measured water levels are referred to as model calibration targets.

The water level data used as calibration targets were compiled from several sources including:

- The 2014 Annual Remedial Performance Report for Chromium and Perchlorate for the NERT Site (ENVIRON 2014c). This report includes data collected as part of the NERT groundwater monitoring program annual sampling event conducted in May 2014, in addition to second quarter 2014 monitoring data received from the other BMI complex parties.
- The Nevada Division of Water Resources (NDWR) online Water Level Database and Well Log Database;
- Quarterly and semi-annual monitoring reports for the BMI complex parties (de maximis 2014a, de maximis 2014b, BRC 2014, AMPAC 2014, GEI 2014b);
- Monitoring data received from the Southern Nevada Water Authority (SNWA); and
- Information collected in 2015 as part of the RI for the NERT Site.

After data compilation was complete, data were evaluated based on the quality of the data source, the date of measurement, and the location of the measurement within the model grid. Each target value was grouped based on these characteristics so that only data of acceptable quality measured during the second quarter of 2014 were used in model calibration. There are 16 targets in the model with water level measurements obtained prior to second quarter 2012. The location of model targets is shown in Figure 11.

The surface water flow measured at the Pabco Road and Three Kids gauging stations were used qualitatively as a calibration targets, so that the simulated stream-aquifer interaction was consistent with the conceptual water balance. Similarly, the boundary flows were also used as qualitative calibration targets.

4.2 Calibration Approach

The Phase III Model was calibrated using a combination of automatic calibration and a trial-anderror approach. Initially, the Phase III Model incorporated parameters assigned from the Phase II Model with updates as discussed above in Section 3.0. As a first step in the calibration process, boundary conditions were adjusted to achieve a reasonable fit between the model and the conceptual water balance. Following initial adjustment of the water balance, model parameters such as vertical and horizontal hydraulic conductivity were modified to provide a better match between simulated heads and observed heads.

The hydraulic conductivity values assigned in Layer 1 in the southern part of the model were adjusted during calibration guided by changes in the degree of saturation of the alluvium and UMCf-cg1. At the southernmost model boundary, the alluvium is unsaturated and groundwater flows mainly in UMCf-cg1. The model calibration started with a conductivity value of 6 feet/day in this area, derived from AMPAC's groundwater model (Geosyntec 2010). This value was increased to 8 feet per day moving to the north as the alluvium becomes partially saturated. On the southeastern side, the conductivity was increased to 10 feet per day where the alluvium is expected to be more saturated since groundwater flows in both the alluvium and UMCf-cg1. Near the NERT Site, the UMCf-cg unit pinches out (Figure 8) and the alluvium is mainly unsaturated. As a result, the upper-most saturated unit is the UMCf-fg, hence a lower conductivity of 2 feet per day was assigned in this region.

In the portions of Layer 1 representing paleochannels, hydraulic conductivity was assigned to zones during calibration guided by the measurements from aquifer testing (Figure 5). The zones were defined with increasing conductivity from the south to the north. For the paleochannel near the SWF, there was significant variability in aquifer test results so the assigned value of 485 ft/d was determined through calibration. A horizontal-vertical anisotropy ratio of 10 was used in the paleochannels. The model calibration is not sensitive to this value, so a reasonable anisotropy ratio representative of alluvium was selected.

Convergence criteria of 0.001 foot on head and 100 ft $3/$ d on flow were specified for the model simulations. The volumetric mass balance error (difference between total groundwater inflow and outflow simulated by the model) was monitored during model calibration as a check on the model solutions and to identify errors in the model design. The overall mass balance error of the final calibrated model was negligible.

4.3 Phase III Model Evaluation

The calibration of the Phase III Model is generally good based on a comparison of model fit to the water budget, calibration target heads, and regional water level contours. Table 5 presents a comparison of the major flow components of the conceptual water balance to the simulated water balance of the Phase III Model. The simulated flows are generally consistent with the estimated conceptual water balance flows.

Table 6 provides a comparative summary of calibration statistics for the updated Phase III Models. A negative residual mean value indicates that the simulated heads are higher than the observed heads. The calibration statistics for the Phase III Model have also been presented separately for higher quality targets versus more uncertain target data, as shown in Appendix A1. Figure 12 shows a plot characterizing the match between modeled and observed heads at wells used as calibration targets. The plot illustrates that there is generally good agreement between modeled and observed heads, with points generally falling close to the 1:1 correlation line. The "goodness-of-fit" R^2 value is 0.98, demonstrating an acceptable fit to the observed heads. Figure 13 shows a map of target residuals.

As shown in Figure 14, the simulated heads in the Shallow WBZ are generally consistent with the contoured groundwater elevations for second quarter 2014 presented in Plate 2 in the 2013- 2014 Annual Performance Report (ENVIRON 2014b).

Based on this evaluation of the Phase III Model, the current calibration is sufficient for the intended purpose of evaluating GWETS performance. Although they are outside of the main area of interest for evaluating GWETS performance, there are several regions within the model domain where high residual values at calibration targets suggest a need for additional model refinement during future modeling work. For instance, in Layer 1, heads west of the NERT Site

boundary and extending downgradient towards the AWF are about 5 to 15 feet higher than the observed water levels. Further refinement of the model layer thickness, layer properties, and/or boundary parameters near these areas may be performed during the RI model development. In addition, the simulated heads appear to be biased low near the upgradient model boundary, particularly in Layer 5. During the RI phase of model development, the deeper coarse-grained UMCf will be added to the model to better represent flow in this layer.

4.4 Sensitivity Analysis

The sensitivity of the model calibration to changes in the values of the hydraulic conductivities was evaluated for the alluvium (outside and within paleochannels), UMCf-fg, and UMCf-cg1. This was done by increasing and decreasing each model input parameters by a factor of 0.75 and 1.5, running the model, recording the outputs of interest, and repeating. The results of the sensitivity analysis are shown in Table 7.

In most cases, the sensitivity analysis results suggest that a lower root mean square (RMS) error could be achieved by increasing horizontal hydraulic conductivities from the values used in the calibrated model. However, this cannot be done without exceeding the range of conductivities observed in the aquifer tests or by creating a discrepancy between the model and the conceptual water balance. The model calibration is not sensitive to vertical conductivities in the alluvium. In addition to the parameters shown in Table 7, the model is also sensitive to parameters controlling the western and southern boundary inflows, the eastern boundary outflow, and upward vertical inflow from the deep UMCf. During the RI phase of model development, a more complete sensitivity and uncertainty analysis will be performed.

5. CONCLUSIONS

The Phase III Model has been calibrated to simulate groundwater conditions at the Site and can be used for evaluation and optimization of the performance of the GWETS. Major refinements to the model described in this report include 1) expansion of the model boundaries to correspond with natural geologic boundaries, 2) further refinement to the model representation of groundwater interaction with Las Vegas Wash, 3) incorporation of hydrogeological data and interpretation developed as part of the COP, and 4) updates to the remediation systems of NERT, OSSM, TIMET, and AMPAC to reflect current operations.

In the Phase 4 model development (to be completed as part of the RI), the model will be further refined to incorporate additional information collected during the RI and any updates to the conceptual site model. As part of this effort, areas of focus will include refining the model representation of the shallow and deeper coarse-grained UMCf units, incorporating new information about stream-aquifer interaction, refining aquifer characteristics with the AMPAC plume, and further improving model calibration. A more complete sensitivity and uncertainty analysis will be performed, and the model will be comprehensively documented in a model report.

6. REFERENCES

- American Pacific Corporation (AMPAC). 2014. BCA Semi-Annual/Annual Monitoring and Performance Report; January 1 to June 30, 2014; Perchlorate Bioremediation System; American Pacific Corporation; Henderson, Nevada. August 14.
- Basic Remediation Company (BRC). 2008. Technical Memorandum: Sources/Sinks and Input Parameters for Groundwater Flow Model, BMI Common Areas and Eastside Area, Submitted to NDEP. March 4.
- Basic Remediation Company (BRC). 2009. Summary Report for Updated Groundwater Flow Model Calibration, BMI Upper and Lower Ponds Area, Submitted to NDEP. November 2.
- Basic Remediation Company (BRC). 2010. Evaluation of Arsenic Occurrence in the Western Hook Development Subarea, Clark County, Nevada, Submitted to NDEP. February 8.
- Basic Remediation Company (BRC). 2014. 2014 CAMU Long-Term Groundwater Monitoring Report; BRC Corrective Action Management Unit (CAMU) Area; Clark County, Nevada. September.
- de maximis, inc (de maximis). 2014a. Quarterly Operations Report; Groundwater Treatment System; Henderson, Nevada; First Quarter 2014. May 14.
- de maximis. 2014b. Quarterly Operations Report; Groundwater Treatment System; Henderson, Nevada; Second Quarter 2014. August 14.
- ENVIRON International Corporation (ENVIRON). 2013. GWETS Optimization Project Work Plan, Nevada Environmental Response Trust Site; Henderson, Nevada. October 18.
- ENVIRON International Corporation (ENVIRON). 2014a. Semi-Annual Remedial Performance Report for Chromium and Perchlorate. Nevada Environmental Response Trust Site; Henderson, Nevada; July 2013-December 2013. February 28. Under NDEP review.
- ENVIRON International Corporation (ENVIRON). 2014b. Remedial Investigation and Feasibility Study Work Plan, Revision 2, Nevada Environmental Response Trust Site; Henderson, Nevada. June 19. Approved by NDEP on July 2, 2014.
- ENVIRON International Corporation (ENVIRON). 2014c. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2013-June 2014. October 31.
- ENVIRON. 2015. Technical Memorandum, Data Gap Evaluation; Regional Groundwater Investigation; Nevada Environmental Response Trust Site; Henderson, Nevada. March 28.
- ENSR International Corporation (ENSR). 2005. Conceptual Site Model Kerr-McGee Facility; Henderson, Nevada. February.
- Federal Emergency Management Agency (FEMA). 2011. Flood Insurance Study, Clark County, Nevada, Volumes 1 and 2. November 16.
- Geosyntec Consultant (Geosyntec). 2010. Groundwater Flow Model, South of Warm Springs Study Area Henderson, Nevada. February 3, 2010.
- Geosyntec Consultant (Geosyntec). 2013. Transient Calibration of Groundwater Flow Model South of Warm Springs Study Area Henderson, Nevada. June 28, 2013.
- GEI Consultants, Inc. (GEI). 2014a. Slurry Wall Construction Quality Assurance Report, TIMET Henderson, Nevada. April.
- GEI Consultants, Inc. (GEI). 2014b. 2014 Annual Groundwater Monitoring Report; Titanium Metals Corporation. October 31.
- Lerner, D. N., 2002. Identifying and quantifying urban recharge: a review. Hydrogeology Journal 10:143-152
- Maxey, G.B. and T.E. Eakin. 1949. Ground Water in White River Valley, White Pine, Nye, and Lincoln Counties, Nevada. State of Nevada, Office of the State Engineer.
- Miller, M. 2006. Rainwater Harvesting for Enhanced Groundwater Recharge Through Capture of Increased Runoff from Site Development. http://opensiuc.lib.siu.edu/ucowrconfs_2006/100
- Nevada Division of Environmental Protection (NDEP) Response to: 2013 GWETS Optimization Project Work Plan, Revision 1; Date November 22, 2013. December 3.
- Northgate Environmental Management Inc. (Northgate). 2010.Capture Zone Evaluation Report.
- PRISM Climate Group (PRISM). 2013. Gridded Climate Data for the Contiguous USA. http://prism.oregonstate.edu.
- Sanford, W. E. and Selnick, D. L., 2013. Estimation of Evapotranspiration Across the Conterminous Unites States using a Regression with Climate and Land-Cover Data, Journal of the American Water Resources Association, Vol. 49, No. 1.Henderson, Nevada. DRAFT. July 22.
- United States Geological Survey (USGS). 1996. Groundwater Conditions in Las Vegas Valley, Clark County, Nevada, Part 2, Hydrogeology and Simulation of Ground-Water Flow. United States Geological Survey Water-Supply Paper 2320-B.
- Vector Engineering Inc. (Vector). 2011. Laboratory Services, Soil Bentonite, Backfill Mix Design Henderson Slurry Wall, Nevada*.* April 12.
- Westernburg, C. L., DeMeo, G. A., and Tanko, D. J.. 2006. Evaporation from Lake Mead, Arizona and Nevada, 1997-99, U.S. Geological Survey Scientific Investigation Report. 2006-5252.

Phase III Groundwater Model Refinement Nevada Environmental Response Trust

TABLES

TABLE 1a: ESTIMATE OF GROUNDWATER DISCHARGE TO LAS VEGAS WASH

Nevada Environmental Response Trust Site

Henderson, Nevada

Notes:

 $cfs = cubic feet per second$ $cfd = cubic feet per day$

¹Per email communication with Gary Carter of AMPAC, dated 9/10/2013.

 2 Per data received from NDEP Bureau of Water Pollution Control in 2015.

³ Estimated using GIS

TABLE 1b: REVISED CONCEPTUAL GROUNDWATER BALANCE SUMMARY

Nevada Environmental Response Trust Site

TABLE 1b: REVISED CONCEPTUAL GROUNDWATER BALANCE SUMMARY

Nevada Environmental Response Trust Site

Henderson, Nevada

UMCf = Upper Muddy Creek Formation COH = City of Henderson

Notes: SWF = Seep Well Field cfd = cubic feet per day AMPAC = American Pacific Corporation IWF = Interceptor Well Field NERT = Nevada Environmental Response Trust AWF = Athens Road Well Field **OSSM = Olin Chlor-Alkali/Stauffer/Syngenta/Montrose**

¹Sanford, W. E. and Selnick, D. L., 2013. Estimation of Evapotranspiration Across the Conterminous Unites States using a Regression with Climate and Land-Cover Data, Journal of the American Water Resources Association, Vol. 49, No. 1.

²Maxey, G.B. and T.E. Eakin. 1949. Ground Water in White River Valley, White Pine, Nye, and Lincoln Counties, Nevada. State of Nevada, Office of the State Engineer.

³Miller, M. 2006. "Rainwater Harvesting for Enhanced Groundwater Recharge Through Capture of Increased Runoff from Site Development." Conference Paper 100, OpenSIUC, Southern Illinois University Carbondale.

TABLE 2: MODEL RECHARGE DISTRIBUTION

Nevada Environmental Response Trust

Henderson, Nevada

Notes:

ft/d = feet per day

cfd = cubic feet per day

COH = City of Henderson

NERT = Nevada Environmental Response Trust

OSSM = Olin Chlor-Alkali/Stauffer/Sygenta/Montrose

Maxey, G.B. and T.E. Eakin. 1949. Ground Water in White River Valley, White Pine, Nye, and Lincoln Counties, Nevada. State of Nevada, Office of the State Engineer.

Miller, M. 2006. "Rainwater Harvesting for Enhanced Groundwater Recharge Through Capture of Increased Runoff from Site Development." Conference Paper 100, OpenSIUC, Southern Illinois University Carbondale.

Sanford, W. E. and Selnick, D. L., 2013. Estimation of Evapotranspiration Across the Conterminous Unites States using a Regression with Climate and Land-Cover Data, Journal of the American Water Resources Association, Vol. 49, No. 1.

TABLE 3: GROUNDWATER EXTRACTION RATES - SECOND QUARTER 2014

Nevada Environmental Response Trust Site

TABLE 3: GROUNDWATER EXTRACTION RATES - SECOND QUARTER 2014 Nevada Environmental Response Trust Site

TABLE 3: GROUNDWATER EXTRACTION RATES - SECOND QUARTER 2014

Nevada Environmental Response Trust Site

Henderson, Nevada

Notes:

cfd = cubic feet per day

gpm = gallons per minute

AMPAC = American Pacific Corporation

OSSM = Olin Chlor-Alkali/Stauffer/Sygenta/Montrose

NERT = Nevada Environmental Response Trust

TABLE 4: PHASE III GROUNDWATER MODEL LAYERS

Nevada Environmental Response Trust

Henderson, Nevada

Notes:

 $ft = feet$

UMCf-fg = Fine grained Upper Muddy Creek Formation

UMCf-cg = Coarse grained Upper Muddy Creek Formation

TABLE 5: MODELED GROUNDWATER BALANCE SUMMARY

Nevada Environmental Response Trust Site

Henderson, Nevada

Notes:

cfd = cubic feet per day

UMCf = Upper Muddy Creek Formation

IWF = Interceptor Well Field

AWF = Athens Road Well Field

SWF = Seep Well Field

AMPAC = American Pacific Corporation

OSSM = Olin Chlor-Alkali/Stauffer/Sygenta/Montrose

Values rounded to two significant figures. The totals were calculated prior to rounding.

TABLE 6: CALIBRATION STATISTICS

Nevada Environmental Response Trust Site

Henderson, Nevada

Notes:

* Selected Targets are the wells with accurate location, screen elevations and water levels available for second quarter 2014.

 $ft = feet$

TABLE 7: SENSITIVITY ANALYSIS

Nevada Environmental Response Trust Site Henderson, Nevada

Notes:

Calibration statistics of calibrated model are highlighted

ft/d = feet per day

ft² = square feet

RMS = root mean square

FIGURES

PHASE III MODEL EXTENT

Nevada Environmental Response Trust Site Henderson, Nevada

Direction of Groundwater Flow 1

Path: H:\LePetomane\NERT\Modeling\Optimization Report\Phase 3 Modeling Report\Figures\Fig 1- Model Extent_v1.mxd

RAMBCLL ENVIRON

EXPLANATION

Phase III Model Extent **NERT Property Boundary**

Geological Map Reference:

E.C.Bingler, 1977, Geologic Map of the Las Vegas SE Quadrangle, Nevada: Nevada Bureau of Mines and Geology Map 3Ag, 1:24,000 scale

Bell, J.W., 1980, Geologic Map of the Henderson Quadrangle, Nevada: Nevada Bureau of Mines and Geology Map 67, 1:24,000 scale

Path: H:\LePetomane\NERT\Modeling\Optimization Report\Phase 3 Modeling Report\Figures\Fig 2- Model Boundary Conditions.mxd

AREA OF PHREATOPHYTES NEAR LAS VEGAS WASH Nevada Environmental Response Trust Site Henderson, Nevada

N.

C r e d i t s :

- SNWA Weirs
	- Phase III Model Extent
	- Area of Phreatophytes

Note: Clark County 4-band digital aerials for March 2014 are shown, image courtesy of Southern Nevada Water Authority (SNWA).

PROJECT: 21-37300A

E X P L A N AT I O N

NERT/AMPAC/TIMET/COH Outfall Location

Pabco Road Stream Gauge Station

- General Head Boundary
- Phase III Model Extent
- **NERT Property Boundary**

EXPLANATION

Boundary Conditions

Specified Flux Boundary

- Ó´! Qal
- \bigoplus Qal/UMCf

Path: H:\LePetomane\NERT\Modeling\Optimization Report\Phase 3 Modeling Report\Figures\Map of Hydraulic Conductivity Values_pump Test.mxd

Notes:

Hydraulic conductivity values are in feet per day.

The hydraulic conductivity estimates are derived from pumping tests except where noted (slug test).

EXPLANATION

Aquifer Test Well Screened Unit

Hydraulic Conductivity (ft/d)

Phase III Model Extent

H:\LePetomane\NERT\Modeling\Optimization Report\Phase 3 Modeling Report\Figures\Fig 6a- Hydraulic Conductivity Dist.mxd WESAC aroe 10/30/2015

6b

KL

Date:
10/28/2015

21-37300A Contract Number: Figure

Drafter: Approved: Revised:

Path: H:\LePetomane\NERT\Modeling\Optimization Report\Phase 3 Modeling Report\Figures\Fig3 -Contact Elevation.mxd

- \div Deep (>200 ft) borehole locations
- Cross-Section Location [1]
- Phase III Model Extent

EXTENT OF SHALLOW UMCF COARSE GRAINED UNIT # 1

Nevada Environmental Response Trust Site Henderson, Nevada

Path: H:\LePetomane\NERT\Modeling\Optimization Report\Phase 3 Modeling Report\Figures\Fig_cg_UMCf_thickness.mxd

UMCf-cg1 thickness (ft)

NOTES [1] Sources of Cross Sections:

Basic Remediation Company (BRC). 2007. BRC Closure Plan, BMI Common Areas; Clark County, Nevada. May.

Earth Tech, 2005. Geologic Cross-Section A-A', Former Montrose Chemical Facility; Henderson, Nevada. July. (full report not found)

ENVIRON. 2014. Remedial Investigation and Feasibility Study Work Plan, Revision 2, Nevada Environmental Response Trust Site; Henderson, Nevada. June 19.

Geosyntec, 2010. Groundwater Flow Model, South of Warm Springs Study Area, Henderson, Nevada. Rev 2. March 31.

Kleinfelder, 1999. Hydrogeologic Investigation, American Pacific Corporation (Former Pepcon Facility); Henderson, Nevada.

Titanium Metals Corporation (TIMET). 2007. Conceptual Site Model. April 25.

MODEL TARGETS Nevada Environmental Response Trust Site Henderson, Nevada

Notes*:

Target Group 1: Accurate information about well location, well screen, and measured groundwater levels.

Target Group 2: Either well location information is approximate or the groundwater level measurements are not for second quarter 2014.

0.5 1 Miles

RAMBCLL ENVIRON

EXPLANATION

Target Groups

 $\overline{2}$ \bullet

Downgradient Plume

NERT Property Boundary

Phase III Model Extent

Path: H:\LePetomane\NERT\Modeling\Optimization Report\Phase 3 Modeling Report\Figures\Fig 10- Simulated Water Levels.mxd

APPENDIX A1 MODEL TARGET GROUNDWATER ELEVATIONS

Nevada Environmental Response Trust Site

Nevada Environmental Response Trust Site

Nevada Environmental Response Trust Site

Nevada Environmental Response Trust Site

Nevada Environmental Response Trust Site

Nevada Environmental Response Trust Site

Nevada Environmental Response Trust Site

Nevada Environmental Response Trust Site

Nevada Environmental Response Trust Site

Henderson, Nevada

Notes:

ft amsl = feet above mean sea level

Group 1: Accurate information about well location, well screen, and measured groundwater levels.

Group 2: Additional observation wells data for second quarter 2012 (well information may not be accurate or the measurements are not for second quarter 2014)

Easting and northing location data and mid screen elevations are compiled from All Well Database (McGinley 2012).

APPENDIX A2 VERTICAL HEAD GRADIENTS (Second Quarter 2014)

TABLE A-2: VERTICAL HEAD GRADIENTS - SECOND QUARTER 2014

Nevada Environmental Response Trust Site

Henderson, Nevada

 1 Well was installed as part of NERT Site Remedial Investigation (RI) in first quarter 2015. Groundwater elevation and vertical gradient shown are based on first quarter 2015 data.

 2 Vertical head differences were presented as part of 2014 Comprehensive Data Evaluation Report for the OSSM site (Hargis and Associates 2014).

³ M-38 is not co-located with M-150 and M-154, but is located approximately 200 feet to the west.

APPENDIX B

CALIBRATION TARGET RESIDUALS

Nevada Environmental Response Trust Site

Nevada Environmental Response Trust Site

Henderson, Nevada

Notes:

ft amsl= feet above mean sea level

ft= feet

APPENDIX C MODEL FILES (Provided Electronically)