Prepared for
Nevada Environmental Response Trust

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Prepared by
Ramboll
Emeryville, California

Date
November 27, 2019

PHASE 6 GROUNDWATER FLOW AND TRANSPORT MODEL

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Phase 6 Groundwater Flow and Transport Model
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

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

Not Individually, but Solely as President of the Trustee

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Date: 11/25/19

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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.

November 27, 2019

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ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
3D	three-dimensional
ADC	Athens Drainage Channel
AMEWs	Auto Mall Extraction Wells
AMPAC	American Pacific Corporation
APEWs	Athens Pen Extraction Wells
AREWs	Athens Road Extraction Wells
AWF	Athens Road Well Field
BMI	Black Mountain Industrial
BOR	Bureau of Reclamation
BRC	Basic Remediation Company
CAMU	Corrective Action Management Unit
cfd	cubic feet per day
COH	City of Henderson
COPCs	contaminents of potential concern
DRIT	deep re-injection trench
DRN	drain package
EGSD	Eastgate Road Storm Drain
ET	evapotranspiration
FBRs	fluidized bed reactors
FS	Feasibility Study
ft	feet
ft bgs	feet below the ground surface
ft/d	feet per day
GCG	generalized conjugate gradient
GIS	geographical information system
gpm	gallons per minute
GWETS	groundwater extraction and treatment system
GWT	groundwater treatment system
HFB	Horizontal Flow Barrier
ISB	In-Situ Bioremediation Treatment System

IWF	interceptor Well Field
IX	ion-exchange
lbs/d	pounds per day
LIDAR	light detection and ranging
LV	Las Vegas
mg/ft^3	milligrams per cubic feet
mg/L	milligrams per liter
MNW1	Multi-Node Well package
NDEP	Nevada Department of Environmental Pollution
NDWR	Nevada Department of Water Resources
NERT Site or Site	Nevada Environmental Response Trust
Northgate	Northgate Environmental Management
NWRA	Nevada Water Resources Association
OSSM	Olin Chlor Alkali products, Montrose Chemical Corporation of California, and Stauffer management Company
OU-3	Operable Unit 3
RI	Remedial Investigation
RMS	root-mean square
RMSE	root-mean square error
SFR	Stream Flow Routing
SFT	Streamflow Transport
SNWA	Southern Nevada Water Authority
sq. ft	square feet
SWF	Seep Well Field
UCMf	Upper Muddy Creek Formation
UIC	Underground Injection Control
UMCf-cg1	coarse-grained facies
UMCf-fg1	fine-grained facies
UNLV	University of Nevada at Las Vegas
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WBZs	water-bearing zones
WEL	Modflow Well package
WRF	Water Reclamation Facility

xMCf	Transitional Muddy Creek Formation
ZVI	Zero-Valent Iron

1. INTRODUCTION

On behalf of the Nevada Environmental Response Trust (the Trust), Ramboll US Corporation (Ramboll) has prepared this "Phase 6 Groundwater Flow and Transport Model" report for the Nevada Environmental Response Trust Site (the NERT Site or Site), located in Clark County, Nevada. The Phase 6 Model is a comprehensive groundwater model of the southeastern portion of the Las Vegas Groundwater Basin that was developed to support the Remedial Investigation and Feasibility Study (RI/FS) of the NERT Site. Figure 1-1 shows the model extent.

The focus of the Phase 6 Model development was to update the previous Phase 5 Model to incorporate new Phase 2 RI, Phase 3 RI, and Downgradient Investigation data and to expand the capabilities of the model to simulate perchlorate contaminant transport. In addition to RI and Downgradient Investigation data, the model incorporates available subsurface investigation data collected by all parties, including the Trust and its consultants, other companies within the Black Mountain Industrial (BMI) Complex, American Pacific Corporation (AMPAC)/Endeavour LLC, and public agencies (e.g., Southern Nevada Water Authority [SNWA], United States Geological Survey [USGS], Nevada Department of Environmental Pollution [NDEP], and Bureau of Reclamation [BOR]). Recent data collected during the Downgradient Investigation and future data to be collected during the Operable Unit 3 (OU-3) RI will be incorporated into the next version of the model. In addition, the next model version will include the capability to simulate transport of other major contaminants of potential concern (COPCs).

Throughout the remainder of this report the Phase 6 Model will be referred to simply as "the model", except where there is a need to differentiate between various versions.

1.1 Model Objectives

The model is a key tool for supporting the NERT RI/FS, the ongoing optimization of the existing groundwater extraction and treatment system (GWETS), and other related activities. The transport model will be used to predict the effect of remedial measures on mass discharge to Las Vegas Wash ("the Wash") and remediation timeframes. The transport model is also being used to calculate the expanded performance metrics, as described in the NDEP-approved RI Study Area Mass Estimate and Expanded Performance Metrics Technical Approach Technical Memorandum (Ramboll Environ 2017), dated October 5, 2017, and to evaluate the effectiveness of the existing GWETS and potential future remedial action alternatives in the forthcoming FS.

The model is designed to include all potential source areas of perchlorate and other NERT COPCs, so that the model can be used to better understand the relative contribution of different source areas to discharges into the Las Vegas Wash and impacts to other receptors. In addition to providing a tool for synthesizing multiple dat.a sources and further developing the conceptual site model, the model can be used for predicting the future impacts to receptors like the Las Vegas Wash under alternative remediation strategies and technologies. This provides a way of systematically comparing the relative effectiveness and timeframe of these alternatives in meeting remedial action objectives.

1.2 Phase 6 Model Refinements

The Phase 6 Model was calibrated to simulate transient groundwater flow conditions between 2014 and 2018. This period was selected because it has a robust concentration data set available to use for calibration of the transport model.

In addition to including the new data in the model, the model has been refined to address NDEP comments on the Phase 5 Model (NDEP 2017). Below is the list of refinements included in the Phase 6 Model:

- The potential impact of density effects on the flow system behavior has been evaluated and is described in Appendix A.
- A complete review of any permitted groundwater pumping (other than the remediation pumping) was completed.
- A detailed assessment of the uncertainty in the boundary recharge fluxes was done and is described in this report.
- The Weston Hills and Chimera Golf course area sub-drains were added to the model.
- The model representation of the Las Vegas Wash was updated to represent conditions at the beginning of 2018.
- The alluvium thickness in the model has been refined based on the borings installed as part of the RI Phase 2, RI Phase 3, and other investigations conducted since 2016.
- The conceptual groundwater discharge to the Wash has been updated based on perchlorate loading at all USGS stream gage stations within the model domain.
- The quarterly conceptual water balance for the model domain has been refined based on additional data collected as part of the RI.
- The model was refined and calibrated based on the additional vertical gradient data collected as part of the RI.
- The vertical conductivities were updated in the model to better calibrate groundwater heads in artesian wells in the model domain.
- The evaporation rates applied to the Wash and the Henderson Bird Viewing Preserve ponds have been updated.
- The southern, western, and the northern model boundaries were updated from general head boundary conditions to specified flow boundary conditions.
- The groundwater model has been re-calibrated to match average quarterly water level targets from 2014-2018.
- The capability to simulate perchlorate transport was added to the model. The transport model was calibrated to perchlorate mass flux to the Wash, perchlorate mass removal from the remediation well fields, and perchlorate discharge to residential sub-drains.

1.3 Report Organization

The report is organized as follows. The model area background and a conceptual water balance for the modeled period is described in Section 2.0 and Section 3.0, respectively. The refinements in the 3D geological model is described in Section 4.0. A description of the groundwater flow model development is provided in Section 5.0, with model calibration described in Section 6.0. Section 7.0 describes the transport modeling approach, Section 8.0 the transport model development, and Section 9.0 the transport model calibration and results. Conclusions are provided in Section 10.0 and references in Section 11.0.

An evaluation of the effects of density on the flow system behavior is provided in Appendix A. The annual distribution of phreatophytes and recharge zones within the model domain are shown on figures presented in Appendix B and Appendix C, respectively. A summary of hydraulic testing results is presented in Appendix D. Measured groundwater elevations and vertical gradient data are presented in Appendix E and Appendix F, respectively. Observed versus simulated head residuals for each model target location during the simulation period are provided in Appendix G. Appendix H has a table with measured perchlorate concentrations at model targets, while Appendix I presents figures showing measured and simulated perchlorate concentrations at each target location. Finally, Appendix J has the model input files. Appendices E through J are provided electronically.

2. MODEL AREA BACKGROUND

The model area is located within the Las Vegas Valley in the southern region of Clark County, Nevada. Las Vegas Valley is surrounded by a set of mountain ranges, including the Spring Mountains to the west, the Sheep Range and Las Vegas Range to the north, the Frenchman Mountains and Sunrise Mountains to the east, and the River Mountains and McCullough Mountains to the south (Figure 1-1). The most significant stream in the valley is the Las Vegas Wash, which flows generally from west to east before discharging into Lake Mead. The climate in the area varies from semi-arid in the mountains to arid in the lowlands. Rainfall averages about 5 inches per year and occurs in storms of high intensity and short duration that often lead to floods. Potential evaporation in the area is significant and can be higher than 80 inches per year in the lower portion of the valley (UNLV 2003).

This section provides background on the model area. The first two subsections describe the geology and hydrogeology of the model area, based on the Tech Memo of RI Data Evaluation (Ramboll Environ 2016c). This is followed by a description of Las Vegas Wash hydrology and environmental remediation activities within the model area. Finally, a summary of previous modeling work is presented.

2.1 Geology

The mountain ranges bounding the east, north, and west sides of the valley consist primarily of Paleozoic and Mesozoic sedimentary rocks (limestones, sandstones, siltstones, and fanglomerates), whereas the mountains on the south and southeast consist primarily of Tertiary volcanic rocks (basalts, rhyolites, andesites, and related rocks) that overlie Precambrian metamorphic and granitic rocks (ENSR 2007).

In the Las Vegas Valley, eroded Tertiary and Quaternary sedimentary and volcanic rocks comprise the unconsolidated basin deposits, which can be up to 13,000 feet (ft) thick (ENSR 2007). The valley floor consists of fluvial, paludal (swamp), playa, and lacustrine deposits surrounded by more steeply sloping alluvial fan aprons derived from erosion of the surrounding mountains (Figure 2-1). Generally, the deposits grade finer with increasing distance from their source and with decreasing elevation. The structure within the Quaternary and Tertiary-aged basin fill is characterized by a series of generally north-south trending fault scarps. Within the model domain, three main hydrogeologic units are present: alluvium, Transitional Muddy Creek Formation, and Upper Muddy Creek Formation. In addition, in the northeast corner of the model domain, the Horse Spring Formation is present near Las Vegas Wash. These geological units are described below:

<u>Alluvium</u>

The uppermost unit is composed of Quaternary alluvial deposits that slope north toward Las Vegas Wash. The alluvium consists of a reddish-brown heterogeneous mixture of well-graded sand and gravel with lesser amounts of silt, clay, and caliche (Figure 2-1). Clasts within the alluvium are primarily composed of volcanic material. Boulders and cobbles are common. Due to the mode of deposition, no distinct beds or units are continuous over the model area.

A major feature of the alluvial deposits is the stream-deposited sands and gravels that were laid down within paleochannels eroded into the surface of the Muddy Creek Formation during infrequent flood runoff periods. These deposits vary in thickness and are narrow and generally linear. These generally uniform sand and gravel deposits exhibit higher permeability than the adjacent, well-graded deposits. In general, these paleochannels trend northeastward. Recent deposits near the Wash are coarse sand and gravels, described as “wash gravels” in the remainder of the report. These deposits are highly permeable and are present beneath and on both sides of the Wash (Figure 2-1).

The thickness of the alluvial deposits ranges from less than 1 foot to more than 50 ft beneath the Site. Soil types identified in on-site soil borings include poorly sorted gravel, silty gravel, poorly sorted sand, well sorted sand, and silty sand. The thickness of the alluvium, as well as the top of the underlying Muddy Creek Formation, was mapped to locate these paleochannels.

Transitional (or reworked) Muddy Creek Formation

Where present, Transitional Muddy Creek Formation (xMCf) is encountered at the base of the alluvium. The Transitional Muddy Creek Formation consists of reworked sediments derived from the Muddy Creek Formation, which is described below. Therefore, the xMCf appears similar to the Muddy Creek Formation, but it consists of reworked, less consolidated and indurated sediments.

Upper Muddy Creek Formation

The Upper Muddy Creek Formation (UMCf) of Pleistocene age occurs in the Las Vegas Valley as valley-fill deposits that are coarse-grained near mountain fronts and become progressively finer-grained toward the center of the valley. Where encountered beneath the Site, the Muddy Creek Formation is composed of at least two thicker units of fine-grained sediments of clay and silt (the first and second fine-grained facies) interbedded with at least two thinner units of coarse-grained sediments of sand, silt, and gravel (the first and second coarse-grained facies). Except for the southernmost 1,000 ft adjacent to Lake Mead Parkway, the first fine-grained facies (UMCf-fg1) separates the first coarse-grained facies (UMCf-cg1) from the overlying Quaternary alluvium at the Site. Within the southern 1,000 ft of the Site, the Muddy Creek Formation’s UMCf-fg1 pinches out along a roughly west-northwesterly trending line. South of this line, the UMCf-cg1 directly underlies the Quaternary alluvium. Other coarse-grained units are found within the UMCf to the east and west of the NERT Site, described further in Section 4.0.

Locally, the UMCf represents deposition in an alluvial apron environment from the Spring Mountains to the west, grading into fluvial, paludal (swamp), playa, and lacustrine environments further out into the valley center. On the Site, the Muddy Creek does not crop out but instead subcrops beneath a veneer of Quaternary alluvium. Since the Site is located closer to the mountains, the upper portion of the UMCf-fg1 unit tends to have zones of sandy silt/silty fine sand as well as a greater number of thin, discontinuous layers of silty sand than in the downgradient plume area, which is farther from the mountains and more toward the interior of the depositional basin.

Horse Spring Formation

In the model area near the Three Kids weir, the Horse Spring Formation and a subunit called the Thumb Member underlie the Las Vegas Wash alluvium. The Horse Spring Formation is a valley fill deposit, consisting of a yellowish-brown dolomitic limestone interbedded with siltstone (GES 2003). The Thumb Member of the Horse Spring Formation consists of reddish brown, interbedded mudstone, and calcareous sandstone with variable amounts of gypsum.

2.2 Hydrogeology

The depth of groundwater varies from near the ground surface for wells near the Wash to about 100 ft below the ground surface (ft bgs) for wells in the southernmost portion of the NERT Site. The groundwater flow direction in the model area is generally to the north (Figure 2-1). This generally uniform flow pattern may be modified locally by subsurface alluvial channels cut into the underlying UMCf (paleochannels), areas of localized recharge from artificial ponds and trenches, and groundwater extraction from remediation system well fields.

NDEP has defined three water-bearing zones (WBZs) that are of interest in the BMI Complex: the Shallow WBZ, which is defined by the first occurrence of groundwater in either the alluvium, xMCf, or the UMCf where the xMCf is missing, is unconfined to partially confined, and is considered the “water table aquifer” (within the depth interval from 0 to 90 ft bgs); the Middle WBZ, which extends from approximately 90 to 300 ft bgs; and the Deep WBZ, which is defined as the contiguous WBZ that is generally encountered between 300 to 400 ft bgs (NDEP 2009). Environmental investigations at the Site have primarily focused on the Shallow WBZ, although recent investigations have included a number of Middle WBZ wells to improve vertical delineation of hydrogeology and chemical constituent distribution.

2.3 Hydrology

Las Vegas Valley is drained by Las Vegas Wash, a 12-mile-long channel which flows into Lake Mead. Accounting for less than 2 percent of the water in Lake Mead, the water flowing through the Wash consists of urban runoff, shallow groundwater, storm water and treated wastewater from the Clark County Sanitation District, the City of Henderson, and the City of Las Vegas. Prior to the development of Las Vegas Valley, the Wash was an ephemeral stream. Currently, the flow is perennial and composed almost entirely of effluent from wastewater treatment plants. This increase in flow caused significant erosion and downcutting of the Wash channel. A program of weir construction was conducted by the Las Vegas Wash Coordinating Committee to address erosion and downcutting. The Pabco Road Weir and part of the Historic Weir were constructed in early 2000. Twelve more weirs have been constructed since 2000 within the model domain. The Sunrise Mountain Weir and the expansion of Historic Lateral Weir, the final weirs planned under the construction program, were completed in 2018 (LVWCC 2019). The locations of weirs within the model area are shown on Figure 2-2.

2.4 Removal Actions, RI/FS-Related Activities, and Remediation by Other Parties

This section presents a summary of removal actions and RI/FS-related activities conducted by NERT and other parties within the model area. Major activities include the operation of groundwater pump and treat systems, installation of slurry walls, and reinjection of treated groundwater. The locations of these activities are presented on Figure 2-3, and an historical timeline is shown on Figure 2-4.

2.4.1 NERT Well Fields

The NERT Groundwater Extraction and Treatment System (GWETS) consists of three well fields that are shown on Figure 2-3 and described below:

Interceptor Well Field

In September 1986, Kerr-McGee Chemical LLC (Kerr-McGee) entered into a Consent Order with Nevada Division of Environmental Protection (NDEP) to undertake groundwater remediation. Installation of the Interceptor Well Field (IWF), processing equipment and a recharge trench was completed during 1987 to remediate chromium impacts to the alluvium. The system has been operating since that time, with semi-annual reports detailing the removal action effort regularly submitted to NDEP.

In 1994, Kerr-McGee completed the Underground Injection Control (UIC) permitting process for the treated groundwater injection trench, associated with this removal action effort. The permit was subsequently modified in December 1998 to allow for injection of Lake Mead water, rather than the treated groundwater (Kerr-McGee 2001). This in turn allowed the treated groundwater to be placed into a holding pond, awaiting further treatment before reinjection or discharge. Beginning in 1998, groundwater recovered and treated by the chromium treatment plant was discharged to an onsite 11-acre pond. This change was instituted to halt recharge of perchlorate-impacted groundwater back to the sub-surface system (Kerr-McGee 2000). Untreated stabilized Lake Mead water was injected through the recharge trenches at or below the rate of groundwater extraction by the interceptor wells. The recharge trenches ceased operation in September 2010. The barrier wall was emplaced downgradient of the IWF in 2001 (ENVIRON 2014b). The locations of IWF pumping wells, barrier wall, and the recharge trenches are shown on Figure 2-3.

AP Area Wells

The AP Area Down and Up Flushing Treatability Study, located approximately 300 ft south of the IWF just west of AP-5, was implemented in 2016 and operated independently of the IWF (Ramboll 2018c). Initial soil flushing and extraction well testing was conducted in October 2016, with continuous operation beginning in November 2016 with three extraction wells, E1-1, E1-2, and E1-3. Flushing and extraction in Plot 2 began in July 2017 with three new extraction wells E2-1, E2-2, and E2-3. Following completion of the treatability study in early 2018, the AP Area extraction wells continued operating as part of the GWETS as requested by NDEP. The locations of AP Area pumping wells are shown on Figure 2-3.

Athens Road Well Field

The Athens Road Well Field (AWF) was initially designed to intercept perchlorate in groundwater downgradient of the IWF and the Site (Figure 2-3). The AWF is approximately 8,200 ft north (downgradient) of the barrier wall and the IWF. The AWF was constructed as a series of 14 groundwater extraction wells screened in the alluvium at seven paired well locations that span approximately 1,200 ft 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 (Ramboll Environ 2016c).

Seep Well Field

The Seep Well Field (SWF) and the seep capture sump[1], located approximately 4,500 ft north (downgradient) of the AWF near the Las Vegas Wash, are shown on Figure 2-3 and were installed in response to the discovery of perchlorate-impacted groundwater migrating (via an intermittent surface seep) to the Las Vegas Wash. In the late 1990s/early 2000s, the groundwater captured from the seep sump was conveyed to an ion exchange unit for treatment (ENSR 1999).

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 the 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 alluvium and across the deepest portion of an alluvial channel (Ramboll Environ 2016c).

2.4.2 OSSM Well Field

The Olin Chlor Alkali Products, Montrose Chemical Corporation of California, and Stauffer Management Company (collectively referred to herein as "OSSM") have been operating the Groundwater Treatment System (GWTS) at the OSSM site since December 1983. The GWTS is operational under a Consent Order between the State of Nevada, Stauffer, and Montrose for groundwater remediation (Hargis 2008). As shown on Figure 2-3, the OSSM GWTS consists of a series of extraction wells and recharge trenches.

Originally, there were thirteen OSSM extraction wells (A, B, C, P, J, D2, E3, L, F, G, H2, K2, and I). In 2008, well M was replaced by new pumping well M2. In 2009, two more wells, N and O, were installed. Wells A and B have been offline since 2011, and two new extraction wells, Q and R, were installed and have been operational since October 2011 (Hargis 2012).

2.4.3 AMPAC Well Fields

The former Pacific Engineering and Production Company (PEPCON) facility manufactured perchlorates from approximately 1958 until 1988. The original PEPCON plant footprint covered approximately 15 acres, and AMPAC owned more than 300 contiguous acres. Endeavour LLC (Endeavour) was created in 2015 to conduct remediation activities at the facility.

An In-Situ Bioremediation Treatment System (ISB) was operated from 2006 to 2012 (AMPAC 2012). The treatment system was comprised of an array of nine extraction wells (6 AREWs [Athens Road Extraction Wells] and 3 APEWs [Athens Pen Extraction Wells]), a water handling and conditioning plant, and a re-injection area (Figure 2-3). The groundwater was pumped from the extraction wells to the processing plant where it was blended, filtered, and then pumped north to the re-injection area located approximately 7,000 ft downgradient near the Las Vegas Wash (Figure 2-3). The original re-injection system design consisted of six re-injection wells (RIWs). A seventh

[1] 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, but it was buried during construction of the Sunrise Mountain Weir by SNWA.

larger diameter well (RIW-5A) was added in July 2008, and a deep re-injection trench (DRIT) located just north of the original RIWs was added in October 2009. The ISB system was shut down in June 2012 and transitioned to an above-ground treatment system (AGTS), which began operation in late September 2012.

Five new extraction wells called Auto Mall Extraction Wells (AMEWs) were installed in January 2012 to extract a higher volume of perchlorate contaminated groundwater from near the former AMPAC site source area. The AMEWs extract groundwater from the Middle WBZ at the depth of 180 ft to 230 ft bgs at a combined rate of approximately 350-450 gpm. An underground effluent HDPE pipeline conveys treated water to a point near Las Vegas Wash. The 14 extraction wells (AMEWs, AREWs, and APEWs) are shown on Figure 2-3.

2.4.4 TIMET Well Field

The TIMET remediation system consists of the slurry wall and groundwater extraction and treatment (GEI 2014). The slurry wall, constructed along the TIMET northern site boundary in 2013, is approximately 2,410 ft in length and extends 60 ft bgs. There is a line of 19 extraction wells screened in the alluvium and extending approximately 3 to 5 ft into the UMCf that was installed in October 2014. The wells are generally located 150 to 160 ft apart and approximately 100 ft upgradient of the slurry wall (Figure 2-3). The alignment of extraction wells EWQal-01 to EWQal-05, located at the northern end, was angled somewhat closer to the wall to capture groundwater that could migrate northward along the wall. At the extreme northern end, well EWQal-01 is located approximately 25 ft from the slurry wall. After treatment using air stripping, the treated water is discharged to a series of six injection trenches located on the downgradient side of the slurry wall.

2.4.5 Weir Dewatering

During the construction of the Sunrise Mountain and Historic Lateral Weirs, groundwater was pumped from dewatering trenches between first quarter 2018 through the third quarter 2018. The water was treated at a temporary treatment plant and then discharged to the Wash near the existing NERT Outfall. The dewatering trench locations are shown on Figure 2-3.

2.5 Previous Groundwater Modeling Studies

Previous versions of the NERT model are described below. Following this discussion, descriptions are provided of several other groundwater flow models that have been developed within the NERT model area and surrounding region.

2.5.1 NERT Steady-State Models

The initial version of the NERT groundwater model was a steady-state model developed by Northgate Environmental Management Inc. (Northgate) that was approved on April 4, 2013 by NDEP for use in capture zone evaluation. This model was calibrated to site conditions in 2008/2009, as documented in the Capture Zone Evaluation Report (Northgate 2010). Refinements to the steady-state model were implemented by Ramboll 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 AMPAC and 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 2014b). 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.

The Phase III Model was documented in an attachment to the 2015 Annual Performance Report (Ramboll Environ 2015). The third phase of model refinements included: 1) an extended model domain to the north and east, 2) a revised stream boundary to better represent the lateral extent and streamflow of Las Vegas Wash, 3) refined areal recharge rates, 4) the addition to the model of the newly installed TIMET extraction well field and barrier wall, and 5) a refined representation of evapotranspiration from phreatophytes based on 2014 aerial imagery. The conceptual water balance was also refined in the Phase III Model report to incorporate additional information and updates to the conceptual model for site conditions existing in second quarter 2015.

The Phase 4 Model was documented in an attachment to the 2016 Annual Performance Report (Ramboll Environ 2016b). Major refinements to the Phase 4 model include 1) expansion of the model boundaries to correspond with natural geologic boundaries on the east side, 2) incorporation of weirs installed on the Las Vegas Wash, 3) independent evaluation of the conceptual water balance for the model, 4) incorporation of boring information to better characterize the geology near the AMPAC site and Las Vegas Wash, and 5) updates to the remediation systems of NERT, OSSM, TIMET, and AMPAC to reflect 2016 operations.

2.5.2 NERT Phase 5 Transient Flow Model

The Phase 5 Model is a transient flow model that simulates the site conditions for the period from 2000 to 2015. It was documented in a stand-alone report (Ramboll Environ 2016a). One of the main objectives of the Phase 5 Model was to develop a consistent interpretation of stratigraphy within the model area based on the smaller-scale investigations conducted at individual sites by different parties. In order to assist with this effort, a three-dimensional (3D) geological model was developed that integrated data from many different sources into a consistent overall model of the major stratigraphic features that control groundwater flow in the model area. The groundwater model was constructed using the stratigraphy from the 3D geological model. As part of the modeling effort, a detailed conceptual water balance of the model simulation period was developed. This water balance was used as the basis for estimating the inflows and outflows of groundwater in the model.

2.5.3 United States Geological Survey Model

A regional groundwater model of the valley-fill aquifer system of the Las Vegas Valley was developed by the USGS to evaluate possible groundwater management alternatives related to overdraft problems while maximizing use of groundwater resources (USGS 1996). The model incorporates processes such as land subsidence due to groundwater withdrawal, discharges to washes, evapotranspiration, and spring flow. The four-layered model consists of 60 columns and 72 rows with uniform grid size of 3,000 ft by 3,000 ft. The model was developed in two phases. In the first phase, the predevelopment groundwater conditions, representing a period from 1912 through spring 1972, were simulated. The second phase model simulated the period from summer 1972 through Spring 1981, representing development conditions. As a part of the modeling efforts, a conceptual water budget was compiled for the two simulation phases.

2.5.4 University of Nevada at Las Vegas Model

A groundwater model representing the transport of perchlorate from several contaminated sites to the Las Vegas Wash was developed by a team at the University of Nevada at Las Vegas (UNLV) on behalf of the United States Environmental Protection Agency (USEPA). The modeling work included a data survey and compilation that aided the characterization of the contaminated sites in terms of topography, geology, hydrology, hydrogeology, and perchlorate distribution in groundwater (UNLV 2003). The computer model was developed for saturated conditions using the software Visual MODFLOW 2.8 and was calibrated using WinPEST, an automated calibration tool. The model results included an evaluation of the time of travel and potential perchlorate migration pathways from the contaminant sources to the Las Vegas Wash. In addition to the time of travel and concentration distribution, the transport model also evaluated the influence of domestic and industrial wastewater disposal via the infiltration ponds on the development of the plumes.

2.5.5 Las Vegas Wash Model

A groundwater transport model was developed by NDEP to study groundwater/surface water interactions and perchlorate transport along the Las Vegas Wash (McGinley 2003; NDEP 2003). The purpose of the modeling work was to develop a predictive tool to address temporal distributions of perchlorate in the Las Vegas Wash. MODFLOW was used to simulate groundwater flow, with the Las Vegas Wash simulated using the River Package. Only the alluvium aquifer system was simulated in the model.

2.5.6 Athens Road Well Field Model

A solute transport groundwater model was developed by McGinley & Associates (McGinley) to quantify the efficiency of capture at the AWF (McGinley 2007).

2.5.7 Basic Remediation Company Model

A groundwater transport model for the BMI Common Areas, developed by Daniel B. Stephens & Associates on behalf of the Basic Remediation Company (BRC), was documented in BRC (2009). As part of the modeling effort, historical, present, and future conceptual water balances of the study area were developed. A series of predictive solute transport simulations were also conducted for perchlorate, arsenic, hexavalent chromium, and selenium.

2.5.8 AMPAC Model

On behalf of AMPAC, Geosyntec Consultants (Geosyntec) developed a conceptual and numerical model of groundwater flow in the area north of the former PEPCON facility (Geosyntec 2010). A steady-state numerical model was developed to validate the conceptual model against available site data and to develop quantitative estimates of design parameters and operations to remediate the perchlorate plume in groundwater that originates at the PEPCON site. The model was implemented in MODFLOW 2000. In 2013, transient stress periods were added to the model to simulate site conditions for

October 2012-May 2013, the first nine months of AMPAC extraction system operations (Geosyntec 2013). For evaluating the groundwater flow in the northern portion of the plume and the Shallow WBZ, the numerical groundwater model was refined and recalibrated as presented in a technical memorandum (Geosyntec 2016). The numerical model was updated to refine the Shallow WBZ, the interaction with the Wash, and the definition of the drains (Geosyntec 2016). The updated model was used to evaluate the capture zone of the groundwater extraction systems in the Shallow WBZ and the area of the distal, northern portion of the Shallow WBZ perchlorate, and the interaction with the Wash. The capture zone evaluation results were submitted to NDEP in a technical memorandum (Geosyntec 2017).

3. CONCEPTUAL WATER BALANCE

A quarterly conceptual water balance was developed for the model area for the simulation period of 2014-2018. The conceptual water balance provides an independent evaluation of the inflows and outflows of groundwater within the model domain that can be used to guide model refinement.

The components of the conceptual water balance are described in this section. The first component of the water balance described is groundwater discharge to the Wash. Once the groundwater discharge to the Wash is estimated, a simple water balance of the Wash was carried out to evaluate losing and gaining stream reaches. Following this, the report describes the methods and data sources used to estimate other sources of groundwater discharge (pumping, evapotranspiration, storm drains, and boundary outflows), as well as recharge (trenches, unlined ponds, land use recharge, and retention basins) within the model domain. Finally, inflows and outflow across the boundaries of the model domain are described.

3.1 Groundwater Discharge to Las Vegas Wash

Since groundwater discharge to the Wash cannot be measured directly, it is estimated indirectly based on the perchlorate mass loading in the Wash. For the Phase 5 Model, groundwater discharge to the Wash was estimated using a water balance approach based on the streamflow data (Ramboll Environ 2016a). However, because groundwater discharge represents such a small fraction of the flow in the Wash, it is difficult to accurately estimate groundwater discharge using this approach. A refined approach has been used for the Phase 6 Model based on the perchlorate mass balance in different stream reaches. This refined approach is feasible now because there are significantly more perchlorate mass loading data available currently than there were when the Phase 5 Model was developed.

3.1.1 Methodology

There are five USGS stream gage stations on the Wash that fall within the model domain: Duck Creek Confluence (#09419698), Pabco Road (#09419700), Bostic (#09419747), Homestead (#09419749), and Three Kids (#09419753). See Figure 2-2. Three of the gages (Duck Creek Confluence, Bostic, and Homestead) were installed in September 2016 by USGS within the model simulation period. There are two gages, Las Vegas (LV) Wasteway (#09419679) and Duck Creek (#09419696), located just upstream of the western model boundary (Figure 2-2). The Duck Creek gage is located on a tributary that joins the Wash just upstream of the Duck Creek Confluence gage. To the east of the model boundary, the Wash flows in a subsurface pipe beneath Lake Las Vegas and resurfaces just before the Northshore Road gage (#09419800), located 3 miles downstream of the Three Kids gage (Figure 2-2). Daily streamflow rates for these stream gages downloaded from the USGS website are shown on Figures 3-1 through 3-7.

To estimate the groundwater discharge to the Wash, the portion of the Wash that adjoins the model domain was divided into five reaches bounded by USGS stream gages: Reaches 1 through 5. Just before the Pabco Road gage, treated effluent is discharged into the Wash at outfalls from the City of Henderson (COH), TIMET, Endeavour, and NERT. The reaches and outfall locations are shown on Figure 2-2 and shown schematically on Figure 3-8. Perchlorate mass loading is calculated at each stream gage. Within each reach, the perchlorate mass discharge is calculated as the difference in mass loading between the downstream and upstream stream gage. The groundwater discharge into each reach is estimated by dividing the increase in mass loading by approximate perchlorate concentration of groundwater discharging in that reach. A similar approach was presented by Dr. Weiquan Dong of NDEP during 2018 Nevada Water Resources Association (NWRA) annual meeting (February 27 – March 1, 2018).

3.1.2 Perchlorate Mass Discharge to the Wash

Perchlorate mass discharge to the Wash has been estimated quarterly for Reaches 1 through 5 (Figure 3-9, Table 1). Quarterly mass loadings were calculated by multiplying the measured perchlorate concentrations in the Wash at nearby transects by the instantaneous streamflow measurements at the time of sampling. As part of the Downgradient Investigation, AECOM also collected perchlorate samples from various locations in the Wash and the mass discharge estimates they reported are included in Table 1 for comparison (AECOM 2019). The estimated values provided by AECOM are similar to the averages determined from the data collected by NERT, where data are available for comparison. Using the average quarterly loading at each location, the perchlorate mass discharge entering the Wash for each reach was calculated by subtracting the loading estimated at the downstream station from the estimate at the upstream station.

As stated previously, the Duck Creek Confluence, Bostic, and Homestead stream gages were installed in September 2016. To estimate the loading at these locations prior to their installation, the total loading between the nearest upstream and downstream gage locations was distributed based upon the average distribution found in 2017. The loading estimates from 2017 were selected because 2017 was the first year in which there was a complete dataset for all gage stations available and there were not any unusual activities such as weir construction or dewatering, which would affect average streamflow. The loading estimates are shown on Table 1 and Figure 3-9.

Within the simulation period there were a few quarters in which either the streamflow or the analytical data were unavailable for this analysis. For example, for the LV Wasteway station the streamflow data were not available between January 2016 through February 2017, while USGS relocated the gage station. Gage information for LV Wasteway became available in March 2017, meaning only one monthly analytical sample was available for the first quarter 2017 (2017Q1). In this case, the average loading from 2017Q2 through 2017Q3 was used to determine the 2017Q1 value. Then, the average of each quarter from 2015 and 2017 was used to determine the respective quarterly averages for 2016 at the LV Wasteway location.

For each of the Bostic and Homestead locations, analytical sampling began at the end of June 2017 and only one analytical sample was available at each location for 2017Q2. Rather than using a single measurement for the quarterly estimate, the average loading from 2017Q3 and 2017Q4 for Bostic and Homestead were used to determine the value for 2017Q2. To estimate the loading during 2017Q1 for the Bostic and Homestead gages, the averages of 2017Q4 and 2018Q4 were used to best reflect the similar seasonal conditions during the winter months. The average values in 2017 were then used to estimate the distribution between reaches for earlier years, as previously described.

At the Three Kids location, unusually high fluxes were observed between the fourth quarter of 2015 through the end of 2016. Perchlorate loading at the Three Kids gage station is expected to be equal to the loading at the Northshore Road station. Hence, for quarterly loading estimates, the large loading values at Three Kids for 2015Q4 through 2016Q4 were replaced with the quarterly averages measured at Northshore Road. The difference between the loading at Northshore Road and Pabco Road was then distributed to the reaches according to the distribution of loading for Reaches 3-5 observed during 2017, as described earlier in this section. For comparison against the total loading estimated for the Wash, the average loading of the raw data from Three Kids has been included in Table 1.

3.1.3 Perchlorate Concentrations in Groundwater Near the Wash

The measured groundwater perchlorate concentrations near each stream reach were estimated using groundwater sampling data near the Wash in the second quarter of each year. In general, monitoring wells were selected using a 300 ft buffer zone to the south of the Wash. For Reach 1, although WMW6.9S is only well located within the 300 ft buffer zone, its location is too close to Reach 2 for its concentrations to be representative of Reach 1. Instead, PMW-8 which is located further away from the Wash was used. For Reach 2, perchlorate concentration data from groundwater sampling of well PC-155A, PC-155B, PC-156A, PC-156B, PC-157A, PC-157B, WMW6.55S, WMW6.15S were used. For Reach 3, data from COH-2B and WMW5.5S were considered. For Reach 4, data associated with groundwater sampling from LNDMW-1 and WMW4.9S were used. For Reach 5, data associated with groundwater sampling from WMW3.5S, which was the only well located within 300 ft buffer zone, was used. The location of these monitoring wells is shown on Figure 2-2.

The ranges of measured groundwater perchlorate concentrations for Reach 1 through Reach 5 were 86 to 120 micrograms per liter (µg/L), 1,800 to 3,400 µg/L, 2,350 to 9,410 µg/L, 1,700 to 2,000 µg/L, and 790 to 1,700 µg/L, respectively, for the model simulation period. The measured perchlorate concentration in groundwater at well WMW3.5S for 2014 (790 µg/L) is almost fifty percent lower than the concentrations measured for this well in other years during the simulation period. Hence, for Reach 5, the groundwater concentration measured in groundwater at WMW3.5S well in 2015 (1,500 µg/L) was used for 2014.

3.1.4 Groundwater Discharge to Las Vegas Wash

The annual average of perchlorate mass discharge for each reach and each year was determined by using the quarterly estimates given in Table 1 as described earlier in this section and shown in Table 2a. The groundwater discharge was calculated by dividing average annual perchlorate mass discharge by the average groundwater perchlorate concentrations in each reach (Table 2a). For the period 2014 to 2017, in Reaches 1-2 the groundwater discharge was estimated in the range of 166,000 to 211,000 cubic feet per day (cfd), and in Reaches 3-5 the total groundwater discharge was estimated from 447,000 to 510,000 cfd. The estimated groundwater discharge for the period 2014 to 2017 was fairly consistent.

In 2018, due to dewatering activities during weir construction, the estimated groundwater discharge in Reaches 1-2 was lower as compared to the estimates for the period 2014 to 2017. For 2018, the estimated groundwater discharge in Reaches 1-2 and Reaches 3-5 were 24,500 cfd and 506,000 cfd, respectively (Table 2a).

3.1.5 Evaluation of Gaining/Losing Stream Reaches

The estimated groundwater discharge in individual reaches indicate that the Wash is in general a gaining stream. However, the groundwater discharge in Reach 3 (in between Pabco Road and Bostic gage stations) is consistently much smaller than the other reaches. The gaining/losing stream reaches were also evaluated by comparing the stream stage to the groundwater elevations measured in transducers installed by AECOM in June 2017 (AECOM 2019). For this evaluation, for each USGS gage station, a co-located transducer was identified on the southern side of the Wash (Figure 2-2). The Duck Creek Confluence gage was paired with the WMW6.9S transducer. Similarly, Pabco Road, Bostic, Homestead, and Three Kids gage stations were paired with COH2B1, WMW4.9S, LNDMW1, and WMW3.5S transducers, respectively (Figure 3-10). The location of the wells with transducers is shown on Figure 2-2. Like the streamflow data, the stream stage data were also available in the NERT Project database that automatically downloads the real time values from the USGS website. This evaluation showed that at the Duck Creek Confluence gage the Wash is a slightly losing stream (Figure 3-10). The transducer data at Pabco Road and Bostic gage stations clearly indicated that the Wash in Reach 3 is a losing reach. The transducers installed at Homestead and Three Kids showed the Wash is gaining in Reach 4 and Reach 5 of the model domain (Figure 3-10).

The USGS has presented a similar evaluation of various reaches of the Wash during the 2018 Annual NWRA meeting (February 27 – March 1, 2018).[2] The USGS also determined that Reach 3 is a losing reach; however, USGS reported that Reach 4 was a losing reach in December 2016, but a gaining reach in August 2017.

3.2 Water Balance in Las Vegas Wash

The groundwater discharge estimates described in the previous section were used to develop a simple water balance for the Wash. The data compiled for this evaluation consist of streamflow data from USGS gauging stations, treated wastewater outflows reported by COH, and the reported effluent discharge rates from the treated water from the NERT, TIMET, and Endeavour sites. A schematic of inflows and outflows is shown on Figure 2-2 and illustrated on Figure 3-8. These flow data are summarized in Table 2b. Reach 1 is roughly 60% within the model domain but all other reaches fall completely within the model boundary (Figure 2-2).

The monthly wastewater effluent flow to Las Vegas Wash reported by COH to NDEP has been compiled from 2014 to 2018 for the Kurt R. Segler Water Reclamation Facility.[3] Annual averages for the COH outfall were approximately 20 cubic feet per second (cfs) in 2014, 21 cfs in both 2015 and 2016, 22 cfs in 2017, and 24 cfs in 2018 (Table 2b). The monthly TIMET outfall discharge rate from 2014 to 2018 was also compiled using data reported to NDEP and then aggregated as annual averages. TIMET outfall was approximately 6 cfs for 2014-16 and 5 cfs for 2017-18 (Table 2b).

For NERT, groundwater is treated using both fluidized bed reactors (FBRs) and an ion-exchange treatment system (IX). The effluent from the FBR and IX systems are combined, and they are collectively discharged to the NERT outfall, which is located on a side channel of the Wash near Pabco Road (Figure 2-2). NERT outfall effluent data are

[2] Presented by Jon Wilson, USGS Hydrogeologist.

[3] https://netdmr.ndep.nv.gov/netdmr/public/home.htm

collected daily and maintained by Ramboll within the NERT Project Database. Daily values have been aggregated as annual averages for each year within the simulation period (see Table 2b).

The daily measured streamflow data are very noisy and show large variations over time. To smooth out the streamflow data, 1-year rolling averages were calculated for each of the seven gage stations along the Wash, as shown on Figures 3-1 through 3-7. For LV Wasteway gage station, there was a data gap in 2016 due to the relocation of the gage station by USGS.[4] Figures 3-1 through 3-7 show that for the period 2014-2018, there were no significant long-term trends in streamflows.

The annual average of measured streamflows for each gage station as determined from the 1-year rolling average is shown in Table 2b. The measured streamflow for each station was calculated as the annual average of flow data below 500 cfs, with flow data above 500 cfs considered outliers. Combined flows from LV Wasteway and Duck Creek gage stations represent the surface water inflow to the model domain (Table 2b). Because no data were available for LV Wasteway in 2016, the surface water flow was assumed to be the same as 2015.

Losses due to evaporation directly from the Wash water surface were accounted for in the water balance using a constant rate. In the Phase 5 Model, an evaporation rate of 78 inches per year was used for the open water bodies. Based on the NDEP comments on the Phase 5 Model, the evaporation rate was revised in the Phase 6 Model by subtracting from the evaporation rate the average rainfall rate of 5 inches per year reported by PRISM (2013). The revised evaporation rate is 73 inches per year, giving total evaporation losses from the Wash from Reaches 1 through 5 of 0.37 cfs, 0.24 cfs, 0.10 cfs, 0.23 cfs, and 0.14 cfs, respectively (Table 2b).

The conceptual net surface water flows at each station were calculated as the sum of surface water flows from upstream, industrial water flows within each reach, if any, and groundwater inflow rates within each reach (as given in Table 2a), minus evaporation from the Wash within each reach. The difference between the conceptual and the measured net surface water flows was equal to or less than 10%, as shown in Table 2b.

3.3 Other Sources of Groundwater Inflow and Outflow

In addition to groundwater discharge to the Wash, other sources of groundwater outflow include groundwater extraction and evapotranspiration. Sources of groundwater inflow include groundwater injection, and both areal and focused recharge.

3.3.1 Groundwater Extraction

Groundwater pumping from 2014 to 2018 was compiled at extraction systems associated with four facilities within the model area: NERT, OSSM, TIMET, and Endeavour (Figure 2-3). Total groundwater pumping rates for individual wells were aggregated from available data for each quarter from 2014 to 2018 (Table 2c).

NERT operates three well fields, including the IWF, the AWF, and the SWF. Endeavour operates three well fields, including the Athens Road Extraction Wells (AREWs), Athens Pen Extraction Wells (APEWs), and Auto Mall Extraction Wells (AMEWs). The AMEW wells were installed in January 2012 to extract a higher volume of perchlorate contaminated groundwater from near the former Endeavour site source area. The AMEWs extract

[4] Based on email communication with Megan Poff of USGS on 6/28/2018.

groundwater from the Middle WBZ at the depth of 180 ft to 230 ft bgs. All other extraction wells are located within the Shallow WBZ at depth up to 90 ft bgs.

The average pumping rates for each quarter for the IWF, AWF, and SWF ranged from 55 to 74 gallons per minute (gpm) (10,546 to 14,281 cfd), 251 to 471 gpm (48,336 to 90,682 cfd), and 481 to 782 gpm (92,795 to 150,443 cfd), respectively. In addition to NERT's three well fields, AP Area wells (shown on Figure 2-3) started operating in the fourth quarter of 2016, with average pumping rates ranging from 5 to 12 gpm (960 to 2,254 cfd) in each quarter from 2017 to 2018. The pumping data for individual NERT extraction wells obtained from GWETS field sheets were summarized quarterly in Table 2c.

For the OSSM system, the combined quarterly average pumping rates ranged from 127 to 163 gallons per minute (gpm (24,448 to 31,313 cfd) for the simulation period (de maximis 2014, 2015a,b, 2016a,b, 2017a,b, 2018a,b, 2019). For the TIMET system, the range of combined quarterly pumping rates was 22 to 47 gpm (4,302 to 8,952 cfd) (GEI 2019). For the Endeavour system, the range of quarterly pumping rate was 561 to 744 gpm (107,929 to 143,207 cfd) within the model simulation period (Endeavour 2019a). The quarterly pumping rates for individual extraction wells operated by other parties are given in Table 2c.

The total quarterly pumping for individual well fields is also summarized in Table 2d. Figure 3-11 shows that the combined groundwater extraction from NERT, OSSM, TIMET, and Endeavour well fields is fairly consistent between 2014 to 2016. However, the combined pumping rates increased in 2017 as a result of increased pumping at the AWF and SWF.

3.3.2 Groundwater Dewatering (Weir Construction)

During the construction of the Sunrise Mountain and Historic Lateral weirs, construction dewatering from trenches occurred during the first quarter 2018 through the third quarter 2018 (Table 2c). Dewatering at Historic Lateral Weir was completed in early June of 2018, with average pumping rates for the first two quarters of 1,132 gpm (217,906 cfs) and 1,026 gpm (197,506 cfs). Dewatering at Sunrise Mountain Weir was completed in late September of 2018, with average pumping rates for the first three quarters of 2018 of 1,561 gpm (300,601 cfs), 2,091 gpm (402,490 cfs), and 904 gpm (174,088 cfs) (Tetra Tech 2018a-d, f, i, k, m-p, 2019a). Since these trenches were located immediately adjacent to the Wash, a significant portion of the water extracted would have come from surface water leakage. For the water balance, we have assumed that 50% of the water extracted from the dewatering trenches originated from groundwater. The resulting quarterly groundwater extraction rates associated with Sunrise Mountain and Historical Lateral Weir construction dewatering are shown in Table 2d.

3.3.3 Other Groundwater Extraction

A comprehensive review of the Nevada Department of Water Resources (NDWR) groundwater pumpage inventories from 2000 through 2018 was conducted in order to identify any other groundwater extraction occurring within the model area. This was done in response to an NDEP comment on the Phase 5 Model report (NDEP 2017). For each year (2000-2018), any non-environmental extraction wells were identified in the groundwater pumpage data available from the Las Vegas Valley Water Use Report from Clark County, Nevada, on the NDWR website.[5]

Ramboll identified two non-environmental (one industrial and one commercial) groundwater wells within the model boundary as shown on Figure 3-12, but neither well was actively pumping during the model simulation period (2014-2018). Also shown on Figure 3-12, there are four wells located just outside the model boundary which had minor amounts of pumping during the model simulation period. None of the wells identified on Figure 3-12 were added to the model since none of the wells were located within the model domain and were pumping during the simulation period of 2014-2018.

3.3.4 Evapotranspiration from Groundwater

Like the Phase 5 Model, a reference ET rate of 5.11 feet per year (0.014 feet per day [ft/d]) was applied to the area covered by phreatophytes. According to a USGS study in southern Nevada (USGS 2008), tamarisk (salt cedar) transpire most of their water from April through October. Hence to account for seasonality, the annual ET rate is distributed among four quarters based on the quarterly averages of evaporation rates available for Lake Mead.[6] The estimated ET rates applied in the model are 0.002 ft/d (Q1), 0.023 ft/d (Q2), 0.022 ft/d (Q3), and 0.010 ft/d (Q4).

The area of vegetation coverage has varied over time due to construction activities near the Wash. The extent of phreatophytes was digitized using a geographical information system (GIS) from aerial photographs provided by SNWA for each year from 2014-2018.[7] Figures showing the extent of phreatophytes for each year are provided in Appendix B.

Applying the quarterly ET rate to the extent of phreatophytes resulted in ET that ranged from 22,000 cfd to 365,000 cfd for the model simulation period of 2014-2018 (Table 2d). In addition to the ET in areas covered by phreatophytes, groundwater evaporates from standing water in the gravel pit located west of the APEW wells (Figure 3-13). According to historical topographic maps and aerial photos, standing water was present in the gravel pit during the entire model simulation period. Using an evaporation rate of 73 inches per year, an additional 12,000 cfd of groundwater is lost through evaporation from the gravel pit.

3.3.5 Areal Recharge

Potential sources of areal recharge identified within the model domain for the period 2014-2018 include rainfall infiltration, as well as recharge associated with golf course irrigation (shown in Appendix C, Figures C1-C5).

Rainfall infiltration was evaluated as a potential source of groundwater inflow in the conceptual water balance based on land use.

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[5] http://water.nv.gov/PumpageInventoryFiles.aspx. The model extent lies within Township 21 South Range 62 East, Township 21 South Range 63 East, Township 22 South Range 62 East, and Township 21 South Range 63 East.

[6] https://pubs.usgs.gov/sir/2006/5252/table8.html

[7] Received from Judith Brandt of SNWA.

Undeveloped Areas

The average precipitation rate for the period from 1980 to 2014 near the Site is approximately 5 inches per year.[8] Historical recharge estimation studies for Nevada groundwater basins have 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) also reported that precipitation recharge is negligible in the valley, consistent with the findings reported by Maxey and Eakin (1949). 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 2012). Hence, consistent with the previous model versions, precipitation recharge in undeveloped areas was considered negligible in both the conceptual water balance and the Phase 6 Model (Table 2d).

Due to an increase in the area of residential land, the total area of undeveloped land decreased over the period between 2014 and 2018.

Residential Areas

Groundwater recharge in residential areas was assumed to originate from municipal water supply lost to groundwater through irrigation and leaky distribution pipelines. Like the previous model versions, a recharge rate of 9.2×10^{-5} ft/d was applied in the residential area within the model boundary.

The area of residential land use within the model domain was estimated from aerial imagery provided by SNWA for each year. During the simulation period, the residential area increased by 12%, from 3.49×10^{8} square feet (sq. ft) in 2014 to 3.90×10^{8} sq. ft in 2018. The majority of the development occurred between 2016 and 2017, accounting for 6% of the increase in residential area. The expanded residential area results in an increase in the total volumetric recharge rate from approximately 32,000 cfd in 2014 to nearly 36,000 cfd in 2018 (Table 2d).

Industrial Areas

The groundwater recharge rate for industrial areas was estimated using a similar approach as described in the Phase 5 Model report (Ramboll Environ 2016a). The groundwater recharge rate from industrial areas within the model domain is approximately 7.3×10^{-4} feet per day.

The estimated recharge rate was multiplied by the total area of industrial land use for each year, which was constant between 2014 and 2017, at 4.01×10^{7} square feet. There was the development of an industrial storage/parking lot area between 2017 and 2018, which accounted for an increase of less than one percent in industrial land use, bringing the total area to 4.02×10^{7} square feet in 2018. The resulting volumetric recharge rate for the simulation period was approximately 29,500 cfd, with an increase of less than 40 cfd between 2017 and 2018 (Table 2d).

Chimera Golf Course

The Chimera Golf Club course in the Tuscany Village development has an irrigated area of 128 acres within the model domain (Appendix C, Figures C1 through C5). This course, opened in 2003, was formerly known as the Tuscany Golf Course. Typically, excess irrigation water is applied to turf grass to prevent salt build-up in the root zone. The

[8] Based on climate data produced by Oregon State University's PRISM Climate Group (PRISM 2013).

amount of turf irrigation water that recharges groundwater can generally be estimated as 25 percent of the annual consumptive use (BRC 2009). The Clark County Area Wide Water Quality Management Plan for 2009 reported the total water usage by the golf course to be 674 acre-feet per year (CCDAQEM 2009). Based on these values, an average recharge rate of 1.78 X 10^{-3} feet per day has been estimated for the golf course area. This corresponds to a total recharge flow of approximately 10,000 cfd (Table 2d). Similar to the Phase 5 Model, it was assumed that the recharge at the golf course was constant for the period 2014 to 2018.

3.3.6 Focused Recharge

Focused recharge from several surface water features in the model domain were evaluated separately and incorporated into the water balance.

COH Wastewater Effluent Ponds

The Kurt R. Segler Water Reclamation Facility (WRF) is presently COH's primary wastewater treatment plant.[9] Currently, effluent from the WRF is disposed via reuse, discharge into the Wash (as described in Section 3.2), and discharge to the Henderson Bird Viewing Preserve (BVP), as shown on Figure 3-13.[10]

Monthly measured flow rates to the ponds of the BVP were obtained from discharge monitoring reports provided by COH.[11] To estimate groundwater recharge, it was assumed that the water surface area of the ponds is relatively constant. Daily and monthly evaporation data were available for Lake Mead from 2011 through 2014; however, the average total evaporation using this dataset was 70 inches per year. When compared with the estimate of 73 inches per year for the stream (see Section 3.2), we would expect a higher evaporation rate for the ponds, as a result of having a shallower depth and walls within the ponds that can facilitate additional evaporation. For this reason, we have instead used older historical averages of evaporation that span from 1953 to 1995, published by USGS[12], with an average evaporation rate of 76 inches per year.

After removing the monthly average of evaporation from the monthly pond outfall estimates, quarterly precipitation estimates were added to the value, resulting in quarterly estimates of recharge at the ponds. Daily precipitation rates reported by USGS were aggregated into quarterly average rates, with the USGS website data automatically being downloaded to the NERT Project database as real time values. The recharge rate from the ponds to the shallow groundwater aquifer for the period 2014-2018 has been determined as quarterly volumetric averages, as shown in Table 2d.

The maximum estimated BVP pond recharge is about 213,000 cfd during 2018Q3 and the minimum recharge is during 2014Q4, with about 53,000 cfd. Generally, the BVP recharge has increased with each year in the simulation period, with an average of 78,000 cfd in 2014, 85,000 cfd in 2015, 121,000 cfd in 2016, 132,000 cfd in 2017, and

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[9] http://www.cityofhenderson.com/utility_services/treatment_facilities.php viewed 11/7/2014

[10] https://www.cityofnorthlasvegas.com/departments/AdministrativeServices/PDFs/BidAds/Bid_1386_4-12-10_Permit_NV0023647.pdf, viewed 11/7/2014

[11] Per data received via email from Howard Analla of the COH, dated 7/09/2013. Data prior to 2008 were obtained via discharge monitoring reports from the NDEP Bureau of Water Pollution Control.

[12] https://pubs.usgs.gov/sir/2006/5252/table8.html

184,000 cfd in 2018. The quarterly estimates have been applied for each stress period in the model simulation and are listed in Table 2d.

COH Pond 13

Periodically, COH discharges off-specification effluent to Pond 13 during periods of treatment plant upset. The location of pond 13 is shown on Figure 3-13. According to COH,[13] Pond 13 usually holds up to a week of off-specification effluent, but is generally never used for more than 4 or 5 days at a time. Where available, daily flow data was compiled from 2014 through 2018 and data was then aggregated as quarterly averages. There was a data gap starting in July 2017, with only sparse daily data available through the end of 2018. Where only sparse data was available, we have used the respective quarterly averages spanning all years, 2014 to 2018, in place of the raw quarterly data.

The annual average flow was found to be approximately 8,000 cfd in 2014, 15,000 cfd in 2015, 30,000 cfd in 2016, 16,000 cfd in 2017, and 14,000 cfd in 2018. The minimum flow of approximately 560 cfd occurred in Q1 of 2015 and the maximum flow of over 86,300 cfd occurred in 2016Q4. To calculate the daily infiltration rate, we used a daily water balance and assumed a maximum infiltration rate of 0.4 ft/d, equal to the vertical hydraulic conductivity for alluvium used in the model. Daily precipitation estimates from USGS, available in the NERT Project database that automatically downloads the real time values from the USGS website, were added to the daily flow estimates, and then the corresponding monthly estimate of evaporation (in ft/d) from Lake Mead was subtracted from the total flow, as done with the COH Wastewater Effluent Ponds, and described in the preceding section. Finally, the lesser value of the assumed infiltration maximum, or the available daily water balance was selected as the daily infiltration rate, in ft/d. Quarterly averages were then aggregated and applied as recharge estimates for Pond 13, as shown in Table 2d.

OSSM and TIMET Recharge Trenches

The OSSM and TIMET sites have operated infiltration trenches just downgradient of their extraction wells for disposal of treated groundwater during the model simulation period. For the OSSM and TIMET sites, focused recharge rates at infiltration trenches were estimated as the quarterly average system extraction rates as described in Section 3.3.1 and as shown in Table 2d. The location of OSSM and TIMET recharge trenches are shown on figures presented in Appendix C.

The TIMET area has been estimated as 8.0×10^4 sq. ft, resulting in an average volumetric recharge rate of approximately 6,800 cfd across the simulation period, with the largest annual average of 8,500 cfd occurring in 2017 and the lowest annual average of 5,100 cfd occurring in 2014. The average recharge rate for TIMET infiltration trenches was 8.50×10^{-2} ft/d, with a maximum of 1.12×10^{-1} ft/d and a minimum of 5.38×10^{-2} ft/d.

The OSSM area has been estimated as 1.6×10^5 sq. ft, resulting in an average volumetric recharge rate of approximately 27,500 cfd across the simulation period, with a maximum annual average of 29,000 cfd occurring in 2018 and the minimum annual average of less than 26,000 cfd occurring in 2016. The average recharge rate for OSSM infiltration trenches was 1.70×10^{-1} ft/d, with a maximum of 1.96×10^{-1} ft/d and a minimum of 1.53×10^{-1} ft/d. The quarterly recharge estimates for both the TIMET and

[13] Phone conversation with Howard Analla of COH on 9/11/2019.

OSSM infiltration trenches have been applied for each stress period in the model simulation and are listed in Table 2d.

NERT Site Storm Water Retention Basins

A recharge flow of approximately 1,800 cfd was assumed for the NERT site storm water retention basins, which has not changed from the Phase 5 Model. In the Phase 5 Model, recharge from storm water retention basins is estimated to be 5.8 X 10^{-4} ft/d (assuming 50 percent of 5 inches per year rainfall recharges groundwater). This value plus the industrial recharge rate of 7.3 X 10^{-4} ft/d was applied to the retention basin areas (as the retention basins are located in industrial areas). The estimated area for these basins is 1.37 X 10^{6} sq. ft, giving an estimated recharge rate of 1.34 X 10^{-3} ft/d, applied as a constant value across the simulation period.

The total estimated annual groundwater recharge for the simulated period is given in Table 2d. The location of these retention basins is shown on figures presented in Appendix C.

Pioneer Detention Basin

The recharge rate of 4.47 X 10^{-3} ft/d and volumetric flow of approximately 1,800 cfd from surface water bodies are unchanged from the Phase 5 Model. The approximate area for this basin is 4.0 X 10^{5} sq. ft and the basin is shown on figures presented in Appendix C. The recharge rate was applied as a constant value across the simulation period and the total estimated annual groundwater recharge is given in Table 2d.

Other historical sources of focused recharge, including the BMI Ponds and the TIMET Ponds, were not active during the Phase 6 Model simulation period and are not included in the water balance.

3.4 Storm Drain Inflows and Outflows

The Athens Drainage Channel (ADC), Eastgate Road Storm Drain (EGSD), and subdrains at the Weston Hills development and Chimera Golf Course have been identified as potential sources of recharge/discharge within the model domain.

Storm Conveyance Channels

According to investigations conducted by AMPAC (2007), groundwater containing perchlorate may seep into the ADC and EGSD (Figure 3-14). The ADC was installed in 1996 and extends to a depth of approximately 18 ft below the grade of Athens Road. In order to relieve groundwater pressure from shallow water tables, the ADC was designed to include regularly spaced weep holes comprised of plastic pipes passing through the concrete channel walls into the underlying soil formations beyond the channel. These weep holes, along with certain concrete joints and a limited number of failure points in the concrete structure, allow groundwater to enter the channel and flow to the north as surface water (AMPAC 2007). According to the 2015 Semi-Annual Monitoring and Performance Report for the AMPAC facility (now operated by Endeavour, LLC), groundwater infiltration into the ADC is currently limited, as the shallow water-bearing zone extraction system at Galleria Drive lowers the water table in the vicinity of the ADC (Endeavour 2016a). Endeavour took over operation of the groundwater treatment system from AMPAC in the second half of 2015.

Other sources of flow into the ADC include the EGSD, a subsurface storm drain 12 ft wide and 6 ft high that runs primarily north-south along Eastgate road, and the F6

French Drain, which de-waters the residential area west of Wiesner Way (Endeavour 2016a). In the 2007 AMPAC Performance Report, it was reported that groundwater was entering the EGSD near Eastgate Road between Cape Horn Drive and Sunset Road. This groundwater would have been carried north to the end of the EGSD before discharging to the ADC at the intersection of Boulder Highway and Galleria Drive (AMPAC 2007). Given that groundwater infiltration into the ADC itself is limited due to operation of the AREW extraction wells, groundwater from the EGSD is believed to be the primary source of perchlorate loading to the ADC (Endeavour 2016a). Flow exiting the ADC re-infiltrates back into the ground near the Wash, just upgradient of the former Endeavour re-injection system (AMPAC 2007).

Endeavour currently measures perchlorate concentrations and flow rates in the EGSD and ADC monthly at the approximate locations shown on Figure 3-14. The sampling location in the ADC is downstream of where groundwater seeps into the ADC and upstream of where surface water re-infiltrates to the groundwater system (just east of Wiesner Way) and is therefore representative of flow received from the EGSD, the F6 French Drain, and any potential groundwater infiltration. The perchlorate mass flux upstream and downstream of the junction with the F6 French Drain is approximately equal, suggesting that the F6 French Drain contributes groundwater but little perchlorate to the flow to the Wash. The total groundwater discharge into the channel should be equal to the seepage into the ground at the exit point, except during the storm season when the flow in the ADC would be higher due to stormflows.

As was done for previous versions of the model, monthly flow data recorded at the EGSD and ADC-Main were tabulated from Endeavour's (formerly AMPAC) semi-annual reports and then aggregated as quarterly averages. For the model water balance, the average flow rate across the simulation period at the ADC is 157 gpm, or 30,227 cfd, with approximately 56% of the average ADC flow originating from the ESGD. The minimum cumulative flow at the ADC was 88 gpm (16,990 cfd) in 2014Q4 and the maximum cumulative flow was 207 gpm (39,870 cfd), occurring in 2017Q2. The annual average flows at the ADC were 116 gpm (22,280 cfd) in 2014, 137 gpm (26,310 cfd) in 2015, 158 gpm (30,450 cfd) in 2016, 198 gpm (38,170 cfd) in 2017, and 176 gpm (33,920 cfd) in 2018 (AMPAC 2014, 2015a,b; Endeavour 2016a,b, 2017a,b, 2018a,b, 2019a). The average flow rate at the EGSD monitoring location for the simulation period was 88 gpm, or 16,920 cfd, with a minimum flow of 64 gpm (12,380 cfd) in 2015Q2 and a maximum flow of 117 gpm (22,450 cfd) in 2014Q1. The flows measured at the EGSD contribute a majority of the total flow observed at ADC for all-but-one of the years during the simulation period, accounting for 73% in 2014, 53% in 2015, 52% in 2016, 48% in 2017, and 60% in 2018. For the EGSD, there was an unusually high flowrate measured during 2014Q3 of nearly 230 gpm and this high value was excluded from the averaging process. The quarterly average flows are listed individually for the ADC and EGSD in Table 2d.

The flow of the ADC channel was applied as focused recharge near the Wash as shown on Figures C1 to C5 (Appendix C). The total volume of water recharging groundwater from the channel near the Wash was assumed to be equal to combined flow rates at the EGSD and ADC channel. However, for future mitigation, Endeavour is planning to pump this captured water to Endeavour's treatment plant for perchlorate removal (Endeavour 2019b). To achieve this, infrastructure improvements at the remediation plant will be made that include design and construction of an overhead pipeline to eliminate potential bottlenecks and installation of a booster pump system on the effluent discharge line (Endeavour 2019b). The construction will reportedly begin in 2020.

Weston Hills and Tuscany Subdrain Systems

The Tuscany development, which surround the Chimera Golf Course, and the Weston Hills development are both equipped with sub-drain systems to help prevent groundwater mounding below buildings. The planned sub-drain locations are shown on Figure 3-15. Ramboll has attempted to obtain the as-built drawings, but has not been successful.

For the Tuscany subdrains, the collection trenches (sub-drains) consist of drain rock and perforated PVC pipe with 6” diameter and 0.02” slot width, oriented across the groundwater gradient (Converse 1998a, 1998b). As part of RI Phase 3 investigations under Modification #2, dated April 19, 2018, the Trust began measuring the flow rate and mass loading in November 2018. Based on data through July 2019, an average discharge of about 50 gpm (9,600 cfd) is expected from the Tuscany sub-drains, which has been applied as a recharge in the area shown on Figures C1-C5 (Appendix C) and presented in Table 2d.

For the Weston Hills subdrains, only sub-drain location information is available, as shown on Figure 3-15. A surface discharge location for the Weston Hills sub-drains has not been identified. It is possible that the discharge from these subdrains is included in the Tuscany sub-drain discharge location.

3.5 CAMU Landfill

The CAMU (Corrective Action Management Unit) landfill is located approximately 10,000 ft west-northwest of the intersection of Lake Mead Drive and Boulder Highway (Figure 2-3). The landfill was built in 2007 and was closed and capped in 2014. The CAMU landfill is situated adjacent to the BMI Landfill which was operated from 1942 until 1980, at which time it was closed and capped (BRC 2007). Hence, the BMI landfill and the CAMU landfill areas were assigned no areal recharge in the model.

3.6 Boundary Inflows and Outflows

In the Phase 5 Model, inflows and outflows of groundwater enter and exit the model domain from several lateral boundaries and were estimated based on precipitation and elevation data using the approach described in Donovan and Katzer (2000) and shown on Figure 3-16. Based on this approach, the mean estimated recharge rates are 470,000 cfd, 56,000 cfd, and 1,600 cfd coming from the west, south, and north boundaries, respectively (Table 2e). The combined inflows from three model boundaries is expected to be approximately 530,000 cfd (Table 2e). In addition to recharge from precipitation, USGS (2004a) estimated an approximate inflow of 190,000 cfd across the southern boundary from the adjacent Ivanpah Valley and Jean Lake Basins (Table 2d).

However, based on NDEP comments on the Phase 5 Model(NDEP 2017), an assessment of the uncertainty for these inflows and outflows has been evaluated. In response to this comment, four other methods described in Donovan et al. (2009) were evaluated to estimate boundary flow rates: Eakin, Watson, Avon and Durbin, and Epstein methods. Similar to Donovan and Katzer (2000) method, these four methods also assume that precipitation increases with altitude, which increases the groundwater recharge rate. The Maxey-Eakin method is an early model which was revised by Eakin to fit valley-specific conditions. The Watson method uses multiple and simple linear regressions to analyze the Maxey-Eakins model. The Avon and Durbin method added more data to the Maxey-Eakins method. Their method upheld that the Maxey-Eakins method was sound and corresponded with other calculations done with modern instrumentation. The Epstein et al. (2010) method works in three parts: analysis of historic recharge methods, analysis of statistical uncertainty, and new estimations of groundwater recharge. Hence for the current evaluation, the boundary flow rates estimated from Donovan and Katzer (2000) methods are compared with the Epstein et al. (2010) method. As part of the uncertainty analysis, the maximum, minimum, and the mean flows were estimated for the two methods for all three boundaries, as presented in Table 2e and further described below.

The Epstein et al. (2010) recharge estimates are generally similar to the Donovan and Katzer (2000) method (Table 2e). The Epstein et al. (2010) method resulted in mean inflow of 7,619 cfd versus 1,645 cfd for Donovan and Katzer (2000) in the northern boundary. Similarly, the Epstein et al. (2010) estimate was larger for the southern boundary (132,814 cfd versus 56,151 cfd). In the western zone the Epstein et al. (2010) method yielded 456,196 cfd, while the Donovan and Katzer (2000) method was 467,890 cfd.

The results indicate that there is considerable uncertainty in the recharge rates and there is a rather large range over which recharge rates could be varied to achieve an acceptable groundwater model calibration. In the northern area, recharge rates can vary between 0 to 16,113 cfd. In the south area, recharge rates have a range of 0 to 634,180 cfd. The western area range is 30,749 to 5,299,981 cfd. The individual boundary inflows rates from the calibrated model are expected to fall within the range given in Table 2e.

With the model domain now extended to the Three Kids gage station, it is assumed that the outflow from the eastern boundary is likely to be small as most of the groundwater outflow is expected to be through the Wash as surface water. An outflow of 25,000 cfd has been assumed from the eastern boundary of the model near the Wash. This value was selected because it produces a balance between the inflows and outflows in the basin water balance for the steady-state stress period of 2014 (Table 2d).

The overall estimated inflows and outflows used for the conceptual water balance are summarized in Table 2d. The water balance for the 2014 steady-state period is also shown on Table 2d, with more details on the steady-state period given in Section 5.5.

4. GEOLOGICAL MODEL DEVELOPMENT

This section describes the three-dimensional (3D) geological model that was developed to support the Phase 6 Model. The primary goals of developing the 3D geological model were to: 1) integrate multiple sources of geologic data into a single conceptual representation of geology in the model area; 2) generate a groundwater model grid aligned with geological contact surfaces with appropriately defined hydraulic conductivity zones; and 3) provide a platform for displaying model outcomes and other visualizations of the model area.

4.1 Major Geologic Units

As shown on Figure 1-1 and described in Section 2, the model area is located within the Las Vegas Valley, a basin bounded by the Las Vegas Range, Sheep Range, and Desert Range to the north; by Frenchman and Sunrise Mountains to the east; by the McCullough Range and River Mountains to the south and southeast; and the Spring Mountains to the west.

The focus of the geological model is representing the unconsolidated materials found in the upper 300 to 700 ft of the model domain. In the Las Vegas Valley, eroded Tertiary and Quaternary sedimentary and volcanic rocks comprise the unconsolidated basin deposits, which can be up to 13,000 ft thick (ENSR 2007). Within the model area, the basin fill is up to approximately 5,000 ft thick, based on a gravity study conducted by USGS (1997). The valley floor consists of fluvial, paludal (swamp), playa, and lacustrine deposits surrounded by more steeply sloping alluvial fan aprons derived from erosion of the surrounding mountains. Generally, the deposits grade finer with increasing distance from their source and with decreasing elevation.

Based on the historical description of stratigraphic units found in the model area, the following geologic formations were included in the geological model:

<u>Alluvium</u>

Quaternary alluvial deposits that generally slope north toward Las Vegas Wash are found throughout the model area. The alluvium consists of a reddish-brown heterogeneous mixture of well-graded sand and gravel with lesser amounts of silt, clay, and caliche. The alluvium is comprised of high permeability paleochannels and wash gravels as described in Section 2.1.

<u>Upper Muddy Creek Formation</u>

The Upper Muddy Creek Formation (UMCf) of Pleistocene age occurs in the Las Vegas Valley as valley-fill deposits underlying the alluvium that are coarse-grained near mountain fronts and become progressively finer-grained toward the center of the valley. In borings from the NERT Site, the contact between the alluvium and the UMCf is typically marked by the appearance of a well-compacted, moderate brown silt-to-sandy silt or stiff clay-to-sandy clay, whereas near the Las Vegas Wash, the contact is marked by gray-green to yellow-green gypsiferous clays and silts. Often, a layer of calichified sediments is observed at the contact. Since the coarse and fine-grained materials comprising the UMCf have different hydraulic effects on groundwater flow, the UMCf has been modelled as two primary sediment types:

- Fine-grained facies (UMCf-fg): Fine-grained sediments of clay and silt
- Coarse-grained facies (UMCf-cg): Coarse-grained sediments of sand, silt, and gravel

Within the model domain, the coarse-grained sequences are associated with depositional events originating from the McCullough Range to the South and Southwest, and from the River Mountains to the Southeast. The model incorporates some interbedding of the coarse and fine-grained facies, guided by the USGS description of thinly interbedded depositional sequences present in the Las Vegas Valley (USGS 1989). The process for delineating the extent of the coarse-grained unit is described in the next section.

4.2 Geologic Unit Modeling

A primary application of the geological model is to help define the layer elevations and zone assignments in the groundwater model. Prior to developing the vertical layering of the groundwater model, the geological contact surfaces within the model domain were simulated in a 3D geological model constructed in Leapfrog Hydro (Leapfrog) software. The lateral extent of the geological model is set to approximately match the model area shown on Figure 2-1, though data that extends beyond the boundary can influence the interpolated contact surfaces. The total depth of the geological model ranges from approximately 350 to 400 ft at the Las Vegas Wash to 600 to 700 ft near the southern and eastern upgradient boundaries.

A number of data sources were applied to delineate the lateral and vertical extents of stratigraphic units in the model. In certain locations, in particular along the model boundaries, measured borehole data were sparse, and the extensions of geological contacts were extrapolated outward from the interior of the model domain or adjusted manually by incorporating control lines in the contact surfaces. Cross sections of the final geological model are presented in Figures 4-1 and 4-2.

4.2.1 Ground Surface

For the Phase 5 Model, LIDAR dataset from 2010 was used to for the ground surface elevation data for the model region obtained from SNWA.[14] The LIDAR data was downsampled to a 50 ft resolution grid for input to the geological model. For the Phase 6 Model, the ground surface elevation was updated using the 2016 LiDAR data obtained from SNWA.[15]

4.2.2 Alluvium

In the Phase 5 Model, the contact elevation surface between the alluvium and UMCf was developed by incorporating following data sets in the Leapfrog model:

- Elevation values for the alluvium-UMCf contact from the NERT Project Database.[16]
- Logs from geotechnical borings drilled near the Las Vegas Wash weirs.
- Geologic cross-sections developed as part of the ongoing NERT Remedial Investigation (RI). These include on-site cross sections presented in the RI Data Evaluation Technical Memorandum (Ramboll Environ 2016c) and westward extensions of these cross sections under development for the forthcoming RI Report.

[14] Received from SNWA via mail on 08/26/2015.

[15] Received from SNWA via mail on 08/28/2017.

[16] The interpretation of the top of UMCf in the NERT Project Database was used to preliminarily define the alluvium interval for each well location. Some locations with suspect data were updated following a more detailed review of available boring logs.

- Geophysical survey data from the Upper and Lower BMI Pond areas (Geovision 2003a) and Las Vegas Wash (Geovision 2003b).
- Structure-contour map and cross-sections developed for the Continuous Optimization Program.
- Cross-sections developed during the Phase III Drilling and Aquifer Testing investigation of areas located between Boulder Highway and Las Vegas Wash (Kleinfelder 2005).
- The surface geology maps for the Las Vegas Southeast quadrangle (Bingler 1977) and Henderson Quadrangle (Bell and Smith 1980), used to define the extent of the alluvium where it pinches out at mountain fronts along the northeast and southwest of the model domain.
- Lithologic logs downloaded from Nevada Department of Water Resources (DWR) Well Logs Database.[17]
- Paleochannel delineations outside of the NERT Site and Off-Site Study Area (Northgate 2010).

For the Phase 6 Model, the contact surface was further updated using the dataset from several recent investigations including:

- Borings logged by Ramboll as part of the Phase 2 RI and Phase 3 RI.
- Borings logged by Tetra Tech as part of several pilot study projects including: the Seep Well Field Area Bioremediation Treatability Study, Galleria Drive Bioremediation Treatability Study, AP Area Down and Upflushing Treatability Study, In Situ Chromium Treatability Study, Unit 4 Source Area In-Situ Bioremediation Treatability Study, and Las Vegas Wash Bioremediation Pilot Study.

The boring logs for the RI Phase 2 off-site borings and RI Phase 3 borings were still draft at the time the geological model was developed. There may be minor changes to these contact elevations in future versions of the model. The updated contact elevation surface between the alluvium and UMCf, shown in Figure 4-3, was defined throughout the model domain.

4.2.3 Upper Muddy Creek Formation

The UMCf underlies the alluvium throughout the model domain and is composed of thicker units of the fine-grained facies interbedded with thinner units of the coarse-grained facies. The geological model integrates deeper contact surfaces defining the boundaries between the coarse and fine-grained facies of the UMCf. To simplify modeling of the UMCf, the fine-grained facies was defined as the primary formation. Volumes defining the coarse-grained areas were then subtracted from the fine-grained formation wherever present.

The lateral and vertical distributions of the UMCf-cg units were interpreted from available borehole data and published cross-sections. Due to the limited number of deep boreholes in the model domain, a smaller dataset was available to delineate the UMCf-cg units, and there was greater reliance on cross-sections and professional judgment.

[17] Well Log Database Query Tool: http://water.nv.gov/data/welllog/ Accessed May 5, 2016.

Particular data sets used to derive the deeper stratigraphy in the geological model included:

- Nevada DWR Well Logs Database.
- Boring logs from deep boreholes drilled upgradient of the BMI Upper Pond area as part of the Deep Background Investigation (GES 2007).
- Boring logs from deep borings drilled on the AMPAC and BMI properties.
- Geologic cross-sections developed as part of the ongoing NERT Remedial Investigation (RI). These include on-site cross sections presented in the RI Data Evaluation Technical Memorandum (Ramboll Environ 2016c) and westward extensions of these cross sections under development for the forthcoming RI Report.
- Draft boring logs from recent borings drilled as part of the ongoing Unit 4 and 5 Building Investigation.

The locations of borings that intersect the UMCf-cg are highlighted in Figures 4-4 and 4-5. Within the geological model domain, the UMCf-cg sequences were associated with depositional series originating from the McCullough Range to the South and Southwest, and from the River Mountains to the Southeast. Conceptually, these sequences were modeled as three separate lateral depositional zones: a “central” region that includes areas on and upgradient of the NERT site, a “west” region that covers portions of the AMPAC site, and an “east” region that extends along the eastern and southeastern model boundary. The three lateral zones were each further subdivided vertically to represent interfingering with the UMCf-fg and disconnected UMCf-cg intervals. The west region was subdivided into three vertical zones, and the east and central regions were subdivided into two vertical zones each[18] (see cross-section A-A’ on Figure 4-1).

The lateral extents of the UMCf-cg depositional zones are illustrated in Figure 4-6. As shown in cross-section Figures 4-1 and 4-2, the different UMCf zones are in lateral and vertical contact in some areas. In certain locations, the youngest and oldest UMCf-cg intervals are vertically separated by bands of UMCf-fg. For all three lateral zones, the UMCf-cg directly underlies the alluvium along the southern and southeastern model boundary. The UMCf-cg does not extend to the base of the model in the west (AMPAC) region.

Figures 4-4 and 4-5 illustrate the total thickness of UMCf-cg and UMCf-fg in the model domain, and the general location of the three depositional zones. Figure 4-4 illustrates the presence of relatively thick deposits along the southern and southeastern model boundaries that thin to the north. Conversely, Figure 4-5 illustrates thickening of the UMCf-fg moving from the southern model boundary towards the wash. The geological model does not fully extend to the base of the UMCf, thus the thickness values shown in Figures 4-4 and 4-5 only represent the thickness of UMCf-cg and UMCf-fg within the model domain.

The xMCf unit, where present in the model, is assumed to be 10 ft thick.

[18] The central zone UMCf-cg intervals correspond to the UMCf-cg1 and UMCf-cg2.

5. FLOW MODELING APPROACH

The results of the conceptual water balance presented in Section 3 and the geological model presented in Section 4 were used as the basis for the development of Phase 6 Model. The key model components that are revised in this version from the Phase 5 Model are described in this section.

5.1 Model Grid

The eastern boundary of the model was extended to Rainbow Gardens Weir to include Three Kids gage station (Figure 2-2). The Phase 5 Model had a uniform grid size of 100 ft by 100 ft. In the Phase 6 Model, the grid was further refined to 50 ft by 50 ft in the well field areas, the Wash areas, and near the unit buildings at the NERT Site. In general, the vertical layering of the MODFLOW grid match layer elevations to geologic contact surfaces wherever possible, while avoiding abrupt changes in layer thickness and elevation. The minimum layer thickness is 4 ft.

Unlike the seven-layer Phase 5 Model, the Phase 6 Model has ten layers, with the top layer designated as Layer 1 and the bottom layer designated as Layer 10. Model Layer 1 represents the alluvium. Layers 2 through 10 represent the UMCf, with hydraulic zones defined to indicate the presence of UMCf-fg (fine-grained) and UMCf-cg (coarse-grained). The UMCf-fg is present throughout the northern portion of the model domain in Layers 3 to 10, and the UMCf-cg is generally present in the central, eastern, and western depositional areas. The layer thicknesses and lithologies represented by each layer are provided in Table 3.

5.2 Simulation Period

For the Phase 6 Model, the simulation period of 2014-2018 was selected because of the availability of concentration data for transport model calibration. There were no major changes to the remediation system during this period, except for pumping rates in the existing well fields (as described in Section 3.3.1).

The model simulation period was divided into twenty quarterly stress periods. Each stress period was assigned recharge rates, evaporation rates, and pumping/injection rates consistent with the conceptual water balance described in Section 3.

5.3 Hydraulic Properties

The summary of horizontal and vertical hydraulic conductivities estimated from various aquifer tests done on different wells in the model domain is presented in Table 4 and Appendix D. The range of hydraulic conductivity values estimated for each geologic unit was used to update the distributions of hydraulic conductivities for various layers in the model as described below.

5.3.1 Horizontal Hydraulic Conductivity

The modeled horizontal conductivity values for each model layer are shown on Figures 5-1 through Figure 5-8. The conductivity values are within measured ranges for each lithologic formation (Table 4) and are very similar to the Phase 5 Model, except as noted below.

- The conductivity for alluvium in Layer 1 was increased from 40 ft/d to 45 ft/d in the model (Figure 5-1).

- The conductivity of the Wash alluvium was increased (from 200 ft/d to 300 ft/d, from 485 ft/d to 550 ft/d, and from 650 ft/d to 700 ft/d) as shown on Figure 5-1.
- For Layer 10, the conductivity values were updated for better calibration of artesian wells as shown on Figure 5-8. A conductivity value of 30 ft/d was used near the southern model boundary for the UMCf-cg to represent confined conditions for the artesian wells.

5.3.2 Vertical Hydraulic Conductivity

A summary of measured values of vertical conductivity is provided in Appendix D and Table 4. In the model, the vertical conductivities were revised from the Phase 5 Model to better calibrate vertical gradients and heads in the lower layers. The conductivity values that have changed from the Phase 5 Model are noted below.

- For the alluvium, the vertical conductivity was decreased from 0.6 ft/d to 0.4 ft/d.
- In the bottom layers, for UMCf-cg, the vertical conductivity was changed from 0.12 ft/d to 0.012 ft/d to simulate confined conditions for the artesian wells.

In general, the values of vertical hydraulic conductivities in the model are higher than the geometric mean of the estimated values for various geologic formations (Table 4). However, the modeled values are within the range of the observed values except for the xMCf, where the modeled vertical conductivity (0.6 ft/d) is set to a value higher than the maximum observed value (5.9×10^{-4} ft/d) in order to improve the calibration.

5.3.3 Storage Properties

Storage properties were assigned based on the geologic unit and were adopted from the Phase 5 Model. The storage properties include the specific yield for unconfined layers and the specific storage for confined layers. Effective porosity, used in particle tracking, was set equal to the specific yield. The storage property values assigned are shown in Table 4. The assigned values are generally consistent with the results of aquifer tests conducted in the model area (Appendix D) and with ranges reported in the literature for similar geologic material types (Todd 1980).

5.3.4 Horizontal Flow Barriers

There are several features within the model area that act as barriers to flow that are simulated using the Horizontal Flow Barrier (HFB) package. These features include the slurry walls at the NERT and TIMET sites, the Frenchman Mountain Fault, and the sheet piles associated with weirs installed along the Wash. The horizontal flow barriers are shown on Figures 5-9 through Figure 5-12 and described below.

<u>NERT Barrier Wall</u>

The slurry wall on the NERT Site is located immediately north of the IWF. This feature is simulated as an HFB boundary. 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 2011). This range was 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, the slurry wall is about 1,600 ft long, 3 ft thick, and approximately 60 ft deep, and was constructed to tie into approximately 30 ft of UMCf (ENSR 2005). The layer thicknesses were adjusted in the model to more accurately represent the slurry wall configuration. An evaluation of the barrier wall integrity demonstrated that the barrier wall is serving its intended purpose (Ramboll 2019a).

The NERT barrier wall is simulated in the top three layers of the model, extending to a depth of 60 feet (Figures 5-9 through 5-11).

<u>TIMET Barrier Wall</u>

The TIMET slurry wall was completed in early 2014. This slurry wall is represented in the model as an HFB boundary. Using information contained in the construction report (GEI 2014), the slurry wall was represented in the model using a hydraulic conductivity of $1x10^{-6}$ cm/sec, a total length of 2,410 ft, and a depth of approximately 60 ft. The thickness of the wall was assumed to be 3 feet.

The TIMET barrier wall is simulated in the top three layers of the model, extending to a depth of 60 feet (Figures 5-9 through 5-11).

<u>Frenchman Mountain Fault</u>

The model domain includes the Frenchman Mountain Fault, located 0.5 miles southwest of the Three Kids Weir (Figure 2-2). This fault is part of the Las Vegas Valley shear zone, a northwest striking, right-lateral strike-slip fault zone (USGS 2005). The last movement on the Frenchman Mountain Fault has been interpreted to be late Pleistocene to early Holocene, approximately 10,000 years before present (GES 2003). According to the geotechnical investigation report for the Three Kids Weir, the upper 30 ft of the Las Vegas Wash floodplain deposits were not offset by the fault in this area (GES 2003). Hence, this fault is simulated in Layers 2 through 10 only. Ramboll is not aware of specific information regarding the hydraulic properties of the fault. For modeling purposes, this fault has been assumed to slightly impede groundwater flow in the units beneath the alluvium. The width of the fault zone has been assumed to be 10 ft with a conductivity value of 0.065 ft/d (which accounts for 10% of the conductivity of Horse Spring Formation).

The fault is simulated in the model for Layers 2 through 10 (Figures 5-10 through 5-12).

<u>Weir Sheet Piles</u>

The weir sheet piles are simulated as HFB boundaries (Figure 5-9 and Figure 5-10). The input parameters for the HFB package remain unchanged from the Phase 5 Model.

5.4 Boundary Conditions

The model boundary conditions include lateral flows of groundwater across the model boundaries, stream-aquifer interaction at the Wash, evapotranspiration, pumping/injection from wells, as well as areal and focused recharge. Boundary conditions applied for the Phase 6 Model are described below.

5.4.1 Lateral Boundary Inflows and Outflows

Lateral boundary flows in the model were defined based on the conceptual water balance. These inflows were simulated using specified flux boundary conditions (WEL package). In the Phase 5 Model, a general head boundary (GHB) condition was used to simulate lateral boundary flows. The location of the boundary conditions is shown in Figure 5-9 through Figure 5-12.

At the southern boundary in Layers 2 through 10, the boundary conditions with higher fluxes were applied in places where the UMCf-cg unit is present. The boundary inflows through the UMCf-fg are expected to be minimal due to the lower hydraulic conductivity of the finer-grained unit. Hence, the southern boundary fluxes in Layers 3 through 10 where the UMCf-fg is present are assigned a smaller inflow.

The western, northern, and eastern model boundary conditions are also simulated as specified flux boundaries in Layers 1 and 2 of the models (Figure 5-9 and Figure 5-10).

5.4.2 Stream Boundary

The stream boundary condition represents the stream-aquifer interaction at Las Vegas Wash. As shown in Figure 5-13, the stream network includes the Wash, Duck Creek, the C-1 Channel, and a small tributary stream carrying surface water discharges near Pabco Road. Like the Phase 5 Model, the Stream Flow Routing (SFR) package (USGS 2004b) was used to simulate stream-aquifer interaction, as well as evaporation from surface water. The stream boundary was divided into a total of 67 segments. The stream segments are defined as parallel to the direction of flow of the stream, with each weir defined by a separate segment to allow the specification of reduced streambed conductivity at the concrete weir structures (Figure 5-13). The segments are not meant to represent the actual flows within portions of the Wash, rather, they are used solely to allow the tabulation of total flows at the stream gages. Inputs to the SFR package include the evaporation rate from surface water, streambed conductance, stream stage, and streambed elevation. The applied evaporation rate to the stream cells is 0.0166 ft/d.

The streambed conductance is a function of the area of the stream in each grid cell, the thickness of the streambed, and the hydraulic conductivity of the streambed. The areal extent of the stream in each stream grid cell was estimated based on 2017 aerial imagery. The streambed thickness was set uniformly to 1 ft, and the streambed hydraulic conductivity was manually adjusted until the groundwater inflow to each stream segment approximately matched the net groundwater inflow calculated in Table 2a. In general, lower conductivity values were applied upstream of Pabco Road where the streambed slope is less steep. Near the weirs, a smaller value of streambed conductivity was used to reflect the lower conductivity of concrete and other materials used in weir construction. The distribution of streambed conductivity values in the model is shown in Figure 5-13. Streambed elevations were obtained from weir construction information received from SNWA (Table 5).[19] Stream stage and streambed elevation profiles are implemented in the stream boundary as shown in Figure 5-14. The depth of the Wash is kept fixed during the simulation.

All weirs have sheet piles installed into the alluvial deposits (and in some cases into the UMCf). The weir sheet piles act as a barrier to groundwater flow, and force groundwater to pass beneath or around the sides of the sheet pile. Like the Phase 5 Model, the sheet piles were simulated using the HFB boundary condition. Table 5 shows which model layers include simulated sheet piles for each weir.

5.4.3 Evapotranspiration from Groundwater

The area of phreatophytes located along the Wash was refined in the model by digitizing areas of riparian vegetation visible in aerial images from 2017 received from SNWA. The

[19] Received from SNWA via email on 02/4/2016.

resulting zones of evapotranspiration are shown on Figure B1-B5 in Appendix B. A maximum evapotranspiration rate of 5.11 ft per year was assigned with an extinction depth of 15 ft, as was used in the Phase 5 Model.

As discussed in section 3.3.4 above, in addition to groundwater loss through phreatophytes, there is an additional loss of groundwater through evaporation from standing water in the gravel pit located west of the APEW wells (Figure 3-13). An evaporation rate of 73 inches per year (as described in section 3.2) was assigned in model Layer 1 in the 76 grid cells where standing water is visible within the gravel pit. An extinction depth of 1 ft was used in these cells to simulate surface water evaporation.

5.4.4 Groundwater Pumping and Injection

Groundwater pumping and injection were simulated using either the standard Modflow Well Package (WEL) or the Multi-Node Well Package (MNW1), with average quarterly rates for the period 2014-2018 for each location shown on Figure 2-3. For each well, the pumping rates, well screen intervals, and corresponding model layers are shown in Table 2c. Treated groundwater pumped into the OSSM, and TIMET recharge trenches was applied as areal recharge in the model at the locations shown in Appendix C.

The WEL package was used to simulate extraction wells screened within one layer. In addition, the WEL package was also used for wells in the IWF, the OSSM and the TIMET well fields because using the MNW1 package caused convergence issues. For wells screened in more than one model layer, pumping was assigned to individual layers based on the proportion of screen in each layer.

The MNW1 package was used to simulate SWF, AWF, and Endeavour wells where the well screen falls in more than one model layers. This package simulates the allocation of pumping from different model layers internally based on the screen interval and the hydraulic conductivity of the formation (Konikow et al. 2009). Well losses were not simulated, and the well radius was set to less than the effective radius of the model grid cell.

5.4.5 Areal and Focused Recharge

Areal and focused recharge has been updated as described in the conceptual water balance in Sections 3.3.5 and 3.3.6, and shown in Appendix C (Figures C1 Through C5) and Table 2d.

5.4.6 Drainage

In addition to the EGSD and ADC, the Golf Course subdrains and Weston Hills subdrains were added to the Phase 6 Model as described in the conceptual water balance in Section 3.4. The location of these subdrains is shown on Figure 3-14 and Figure 3-15. These drainage channels are simulated in the model using the drain (DRN) package.

Since the location of the F-6 French drain is unknown, a hypothetical drain boundary was added to the west of the ADC in order to match the flow observed in the ADC, as shown on Figure 5-9. The reference elevations were initially defined to be in the middle of Layer 1 under the water table. Then the drain conductance and reference elevations were adjusted to match the measured flow (Table 2d).

5.5 Model Initial Heads and Transient Simulation

The initial condition for the transient simulation was defined using a steady-state simulation representing average groundwater conditions in 2014. For this purpose, an additional stress period (in steady-state) is added to the model at the beginning of model simulation. For this stress period, the boundary conditions and various inflow parameters are assigned based on annual averages in 2014, as shown in Table 2d. Thus, the model has a total of twenty-one stress periods, with the first stress period being steady-state and the remainder transient.

5.6 Modeling Software

The Phase 5 Model was simulated using the USGS modeling code One-Water Hydrologic Flow Model (MODFLOW-OWHM) version 1.00.00 (Hanson et al. 2014) in order to represent the installation of slurry walls and sheet piles below weirs that occurred during the simulation period. With the change in simulation period, there is no need to include a representation of weir installation in the Phase 6 Model, so the model was developed using the simpler USGS modeling code MODFLOW-NWT Version 1.1.4 (Niswonger et al. 2011). Most of the model input files were generated using the Groundwater Vistas interface (Version 7.24 build 70), with the exception of the SFR input file. A complete set of model files is included in Appendix J.

6. FLOW MODEL CALIBRATION

The Phase 6 Model was calibrated by varying the model parameters so that the simulated model results are consistent with the observed 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 the model calibration.

6.1 Calibration Objectives

The model was calibrated using a combination of automatic calibration and a trial-and-error approach. The model calibration objectives were as follows:

- To match the major flow components of the conceptual water balance (including pumping, surface recharge, and flow in the drainage channel), as given in Table 2d.
- To match simulated groundwater discharge to the Wash within 15% of the conceptual estimates.
- To obtain a volumetric mass balance error of less than 1%.
- To match head targets with a residual standard deviation to range ratio of less than 10% for non-artesian wells and less than 20% for artesian wells (since artesian wells are hard to calibrate with a regional model).
- To obtain predicted capture zones for each of the well fields that are consistent with the conceptual site model.

6.2 Model Calibration Targets

The measured groundwater levels are referred to as model calibration targets. During model calibration, model parameters were adjusted so that the simulated water levels were as close as possible to the head calibration targets. Two types of head calibration targets were used in the model: 1) groundwater elevation targets and 2) head difference targets. The model was also calibrated to the streamflow estimates and the pumping rates as given in Table 2d. The methodology and data sources for these targets are as described below.

<u>Groundwater Elevation Targets</u>

The average quarterly groundwater level data for 2014-2018 were compiled from the NERT Project Database of groundwater elevations. There are several sources including:

- Data collected by the Trust in 2014-2018:
    - Data from the Groundwater Monitoring Program (Ramboll Environ 2014, 2015, 2016b; Ramboll 2017, 2018c, 2019b);
    - Data from Phase 1-3 of the RI;
    - Data from treatability studies;
        - Zero-Valent Iron (ZVI)-Enhanced In-Situ Groundwater Treatability Study (Ramboll 2018a);
        - AP Area Treatability Study (Tetra Tech 2018h);
        - Galleria Drive Bioremediation Treatability Study (Tetra Tech 2018l);
        - Groundwater Bioremediation Study (Tetra Tech 2016);

    - In Situ Chromium Treatability Study (Tetra Tech 2018e);
    - Las Vegas Wash Bioremediation Pilot Study (Tetra Tech 2017b, 2018r);
    - Seep Well Field Area Bioremediation Treatability Study (Tetra Tech 2019b);
    - Soil Flushing Treatability Study (Tetra Tech 2017a); and
    - Vacuum Enhanced Recovery Treatability Study (Tetra Tech 2018g);

- Data received directly from BMI complex parties in 2014-2018 for use in the Annual Remedial Performance Reports for Chromium and Perchlorate for the NERT Site (Ramboll Environ 2014, Ramboll Environ 2015, Ramboll Environ 2016b; Ramboll 2017, Ramboll 2018c, Ramboll 2019b);
    - Data provided by Endeavour;
    - Data provided by OSSM; and
    - Data provided by TIMET;
- Data received from SNWA in 2014-2018 for use in the Annual Remedial Performance Reports for Chromium and Perchlorate for the NERT Site (Ramboll Environ 2014, Ramboll Environ 2015, Ramboll Environ 2016b; Ramboll 2017, Ramboll 2018c, Ramboll 2019b); and
- Data received from BRC in 2014-2015 for use in the Annual Remedial Performance Reports for Chromium and Perchlorate for the NERT Site (Ramboll Environ 2014, Ramboll Environ 2015, Ramboll Environ 2016b; Ramboll 2017, Ramboll 2018c, Ramboll 2019b).

After data compilation was completed, data were evaluated based on the quality of the data source, the date of measurement, the location of the measurement within the model grid, and the amount of data available in the period between 2014 and 2018. Dry wells were not included. In total, there were 1039 wells and 12,869 groundwater elevation measurements considered for 2014 to 2018. For the first time step (0.5 day), which corresponds to the flow model steady state simulation, the average groundwater elevations in 2014 were used as targets and 465 annual targets were considered. For the transient model, the targets were averaged on a quarterly basis in order to compare them against the simulated quarterly stress periods. There were 6,656 quarterly water level targets used for 2014 - 2018 transient model calibration.

The frequency of measurement varied with time and location. In order to address the quality of available data, weights were applied to targets. A simple weighting scheme was used based on the statistical principle that the accuracy of the mean is proportional to the square root of the number of samples. Weights of each quarter target were set to one-half the square root of the number of quarters with one or more head measurements for that location and quarter. The maximum value of weights is set to be 1 for wells with frequent data.

The model layer in which target wells are screened was determined from well construction information stored in the NERT Project Database.

The representative groundwater elevation targets used for model calibration are tabulated in Appendix E and are shown on Figure 6-1 for 2014 targets and Figure 6-2 for 2018 targets. As a result of additional investigations conducted after 2014, there are additional targets in 2018.

Head Difference Targets

The target locations for the vertical head differences are shown in Figure 6-3. Representative head difference/vertical gradients at various well clusters used for model calibration are tabulated in Appendix F. Tables F-1a to F-1e show vertical gradients that were calculated from manual groundwater elevations from 2014 to 2018, respectively, and Tables F-2a to F-2b show vertical gradients that were calculated from locations with automatic transducers from 2017 to 2018, respectively.

Vertical gradients were calculated from manual groundwater elevations measured as part of routine groundwater monitoring within the RI study area. Locations used for this portion of the analysis included all available and applicable wells in the NERT Project Database, using the same selection method for head targets. First, clusters of wells within a 100-ft radius (and a 50-ft depth radius) were identified. A cluster of wells also needs to have at least 50-ft vertical distance between the highest midscreen elevation and the lowest midscreen elevation. In total there were 84 clusters identified (Figure 6-3). Quarterly vertical gradients were then calculated for each well cluster from quarterly averaged groundwater elevation data in 2014-2018. For each cluster, the well which has the highest elevation was identified as "Top" and was used as the reference well. Vertical gradients were calculated for other wells in the cluster by using the following equation.

$$\text{vertical gradient for well A} = \frac{\text{groundwater elevation of reference well} - \text{groundwater elevation of well A}}{\text{midscreen elevation of reference well} - \text{midscreen elevation of well A}}$$

A positive vertical gradient means the water is flowing downward. The midscreen elevation, midscreen depth below ground surface, model layer, WBZ, and lithology in screen interval for each well can be found in Appendix F. In 2014Q1, 2014Q3-4, 2015Q3-4, and 2017Q1, no vertical gradient could be calculated due to lack of data. For each quarter, clusters that have data available are shown in Tables F-1a to F-1e. A cluster is shown when there are head data available for at least one well in the cluster.

Additionally, vertical gradients were calculated from locations with automatic transducers using the same approach. There were 8 clusters identified (Figure 6-3). Data were available from 2017 to 2018 (Tables F-2a and F-2b). Locations used for this portion of the analysis were wells in the Eastside and Downgradient Study Areas, with transducers installed in 2017 in support of the groundwater monitoring program. Data analyzed in this effort included all available well transducer data points from 2014 to 2018 in the All Wells Database on June 7, 2019. Automatic transducer elevation data was averaged across the quarterly time interval, and manual elevations were used as a quality control check. The vertical gradient was calculated for all Alluvium/UMCf well pairs where data was available for both wells.

Other Calibration Targets

Boundary inflows and groundwater discharge rates to the Wash developed in the conceptual water balance were used qualitatively as calibration targets. Additionally, groundwater extraction rates were used as qualitative calibration targets. The estimated boundary flow rates and pumping rates are provided in Table 2d.

6.3 Model Calibration

The Phase 6 transient model was manually calibrated to the water levels and the conceptual water balance for the simulation period (2014-2018) by adjusting the fluxes at the specified flux boundary located at the southern and western boundaries of the model domain. The horizontal hydraulic conductivity values are modified slightly from the Phase 5 Model for better calibration as previously described in Section 5.3.1. The conductivity for alluvium in Layer 1 was increased to 45 ft/d. In the Phase 5 Model, an alluvium conductivity of 40 ft/d was used. This change was made to improve head calibration in shallow water bearing zone wells. The conductivity of the Wash alluvium has been increased (from 200 ft/d to 550 ft/d, from 485 ft/d to 550 ft/d, and from 650 ft/d to 700 ft/d) in the Phase 6 Model as shown on Figure 5-1. This helped improve the match between the conceptual groundwater discharge to Wash and the simulated discharge volume. For Layer 10, the conductivity values were updated for better calibration of artesian wells as shown on Figure 5-10. A conductivity value of 30 ft/d was used near the southern model boundary in UMCf-cg to represent quasi-confined conditions for the artesian wells.

The vertical hydraulic conductivity values were modified throughout the model domain to improve the calibration at the head targets. The vertical conductivity value of the alluvium was decreased from 0.6 ft/d in the Phase 5 Model to 0.4 ft/d. Like the previous model versions, the vertical conductivity in the rest of the geologic units (paleochannels, Las Vegas Wash sediments, UMCf-fg, xMCf, and UMCf-cg) was defined by multiplying the horizontal conductivity by a vertical-to-horizontal anisotropy ratio of 0.1. The calibrated vertical conductivity values in the model are above the estimated geometric mean but are within the range of measured values (Table 4 and Appendix D).

In the model, the hydraulic conductivity assigned to the streambed was adjusted during calibration to obtain a good match between simulated groundwater discharge in Reaches 1 through 5 and the estimated groundwater discharge in the conceptual water balance. The fluxes at the western inflow boundary were adjusted during calibration to match the groundwater flux to the Wash in the stream sub-reaches. The calibrated conductance applied for each stream segment is given in Figure 5-21. The net groundwater outflows from the calibrated model into various reaches of the Wash is within 15% of the values estimated in the conceptual water balance shown in Table 2d.

Convergence criteria of 0.01 ft on head and 500 cfd on flow were specified for the model simulations. The volumetric mass balance error (difference between the 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.

6.4 Model Evaluation

The calibration of the flow model is generally good based on a comparison of simulated and conceptual water budget, simulated and observed heads, and simulated and conceptual groundwater discharge to the Wash. Table 6 presents the major flow components of the simulated water balance of the Phase 6 Model. The overall mass balance error of the final calibrated model was negligible.

There is generally a good match between the conceptual water balance and the simulated water balance. The combined simulated boundary inflows are approximately

840,000 cfd for the simulation period. There is uncertainty in the conceptual measurement of boundary inflows as presented in Table 2e. Thus, the simulated value of boundary flows is reasonable as compared to the conceptual range of combined boundary inflows of 1,100,000 cfd (Table 2d). The total simulated pumping rates for individual extraction wells matches the measured pumping rates given in Table 3. Although there is uncertainty in the conceptual estimates of groundwater discharge to the Wash, the simulated groundwater discharge to the Wash is within 15% of the conceptual estimates (Table 6).

Table 7 provides a summary of target residual statistics for 6,656 observations evaluated for the calibration of the Phase 6 Model. The overall average target residual in the calibrated model is -3.02 ft. A negative residual value indicates that the simulated head is higher than the observed head. There is a root-mean-square (RMS) error of 5.9 ft with the range of observation of 435 ft. The residual standard deviation of the model targets is 5.2 ft. A model is considered well calibrated when the ratio of residual standard deviation and the range of observed groundwater head elevation values is less than 10 percent (Hill and Tiedeman 2007). For the Phase 6 Model, this ratio is about 1.4% percent.

As the deep artesian wells are hard to calibrate within a regional model, for the Deep WBZ (Layers 9 and 10), the calibration statistics of groundwater elevation targets have been evaluated separately (Table 7). The average target heads in these layers is about 10 ft lower than the measured values (target residual of 10.08 ft). The positive value of head residual indicates that the simulated heads are underestimated. There is RMS error of 16.1 ft with the range of observation of 339 ft. The ratio of residual standard deviation and the range of observed heads in the Deep WBZ is 4.8%. The calculation of the target residuals for each target location is shown in Table G-1 (Appendix G).

Figure 6-4 and Figure 6-5 show a scatter plot characterizing the match between modeled and observed groundwater heads and head differences at wells used as calibration targets, respectively. The plots illustrate that there is generally good agreement between modeled and observed heads, with most points falling close to the 1:1 correlation line. The “goodness-of-fit” R^2 value is 0.99, demonstrating an acceptable fit to the observed heads. The head difference/vertical gradient in Figure 6-5 also demonstrates an acceptable fit except a few outliers. There is in general an upward vertical gradient of heads within the model domain as presented in Appendix F. The vertical gradient results were highlighted in yellow for wells where the simulated vertical gradient had an opposite direction compared to the observed vertical gradient (Appendix F). The target locations for the vertical head difference are shown on Figure 6-3. The well clusters where the simulated vertical gradient had an opposite direction compared to the observed vertical gradient in any stress period of the model simulation are shown on Figure 6-3. For the transducer data, at every location the simulated vertical gradient direction matched the observed vertical gradient (Appendix F-2a and F-2b).

There is a good fit at the vast majority of targets, with differences between observed and simulated head generally less than 10 ft (Table G, Appendix G) for the Shallow WBZ. Table G shows the distribution of targets in between Shallow, Middle, and Deep WBZs. The match between simulated and observed heads in these zones appears reasonable. For the treatability study wells, the model calibration only used the baseline data points. Figure 6-6, Figure 6-7, and Figure 6-8 show the head residuals in Shallow, Middle and

Deep WBZs, respectively. The head residuals shown on these figures are averaged over the model simulation period 2014-2018.

Simulated groundwater discharge to the Wash in the stream reaches also approximately matches the conceptual flow for the water balance period. The observed versus simulated streamflow at various USGS gages is shown on Figures 6-9 through 6-13. The overall simulated streamflow at each gage station is approximately similar to the 1-year rolling averages of the measured streamflow values for the period 2014-2018.

The observed versus simulated groundwater discharge in ADC drains is shown on Figure 6-14. The overall trend of simulated discharge in ADC matches reasonably with the measured discharge data as given in Table 2d. Due to limited information on these sub-drains, the conceptual estimate of discharge in the sub-drains is approximate. As a result, the simulated discharge from Weston Hills and Tuscany Golf course sub-drains was not evaluated.

In order to evaluate the capture zones predicted by the model, a particle tracking simulation was performed. Capture zones were estimated using particle tracking for quasi-steady-state conditions existing in 2017. The capture zones for the groundwater extraction systems in Shallow, Middle, and Deep WBZs simulated using the Phase 6 Model are shown on Figures 6-15, 6-16, and 6-17. A qualitative comparison of these capture zones with those based on the Phase 5 Model presented in the 2017 Annual Report indicate that the general configuration of the capture zones for each extraction system remains consistent with the previous model version.

The model is further evaluated by comparing the observed versus simulated heads for Q2-2018 as presented on Figure 6-18. The observed potentiometric contours are from 2018 Annual Report (Ramboll 2018c). The simulated heads are the water table contours exported from the model at the end of 19th stress period representing Q2-2018.

6.5 Sensitivity Analysis of Flow Model

A sensitivity analysis was conducted to evaluate the effect of model input parameter uncertainty on significant model outputs. The model input parameters evaluated included: 1) hydraulic conductivity of major geologic units, 2) surface recharge rates, 3) streambed conductance, 4) storage parameters, and 5) southern and western boundary inflows, and 6) evapotranspiration. The sensitivity analysis was performed by changing each of these model input parameters by a factor of 0.75 and 1.25, running the model, and recording the outputs of interest.

The model outputs evaluated for the sensitivity analysis included: 1) calibration statistics based on target water levels, 2) the difference between simulated and actual discharge to the Wash, and 3) the difference between simulated and actual pumping at extraction wells. The results of the sensitivity analysis for these outputs are shown in Table 8, with the exception of the difference for extraction well pumping, which showed no effective difference in the root mean square error (RMSE) (3.22×10^5 cfd) as a result of increasing or decreasing any of the input parameters.

Hydraulic Conductivity

The sensitivity of the model calibration to changes in the value of the hydraulic conductivity was evaluated for the alluvium (both outside of and within the paleochannels), the UMCf-fg, and the UMCf-cg. As shown in Table 8, the model calibration is relatively insensitive to vertical conductivities in each of the lithologic units, with most effects occurring within the UMCf-cg. For the horizontal conductivity parameters, the sensitivity analysis results suggest that a lower sum of squared residuals, RMSE, and residual mean for the groundwater elevation could be achieved by slightly increasing or decreasing hydraulic conductivities from the values used in the calibrated model. However, this cannot be done without causing a significant increase to the RMSE for the discharge to the Wash. The only sensitivity run where groundwater elevation statistics were reduced without significantly increasing the RMSE for the discharge to the Wash was the result of increasing the horizontal conductivity within the paleochannels. For this parameter, the associated RMSE for the discharge to the Wash is higher by only 0.4 cfs, which is considered negligible. Further, the calibrated conductivity for the paleochannels is already at the upper end of the range of reasonable values, as presented in Table 4, which indicates that it would not be reasonable to increase the conductivity of the paleochannels to achieve lower statistics.

Surface Recharge

The sensitivity of surface recharge rates was evaluated by uniformly varying the recharge rates shown in Table 2d by factors of 0.75 and 1.25. As shown in Table 8, all three calibration target statistics changed when the recharge rates were modified, indicating that recharge rates are sensitive model parameters. As with the results for horizontal conductivities, although there were lower statistics associated with decreasing the recharge rates by 25%, doing so would result in a much larger RMSE for the discharge to the Wash. Conversely, increasing the recharge rates by 25% results in higher groundwater elevations, but a slightly lower RMSE for the discharge to the Wash.

Streambed Hydraulic Conductivity

Streambed hydraulic conductivity, which controls stream-aquifer interaction, is an uncertain model parameter due to the lack of any direct measurement data. As shown in Table 8, the model calibration statistics based on groundwater elevations or observed pumping are not sensitive to this parameter. As expected, streambed conductivity does influence the rate of groundwater outflow to the Wash as indicated by the RMSE values.

Storage Parameters

The effect on calibration statistics was evaluated by changing specific yield and specific storage values by factors of 0.75 and 1.25. The model results are not especially sensitive to storage parameters, with the exception of the RMSE for the discharge to the Wash, which increased from about 1.9 cfs to about 2.2 cfs with either an increase or decrease to the calibrated storage values (Table 8).

Boundary Inflows

Boundary inflows are uncertain because they cannot be measured directly. As shown in Table 8, the model calibration is sensitive to parameters controlling the southern boundary inflow but not as sensitive to changes in the western boundary inflow. Like other input parameters in the sensitivity analysis of flow, the effect on calibration statistics was evaluated by changing each of these boundary inflows by factors of 0.75 and 1.25. A decrease to the southern and western boundary inflows results in lower statistics for the groundwater elevation, but a significant increase in the RMSE for the discharge to the Wash for both boundaries. Further, when the southern boundary inflow is decreased, the pumping at the shallow OSSM, IWF, and TIMET well fields that can be simulated by the model is reduced from the actual pumping rates, resulting in a difference in total pumping of 4.05×10^6 cfd. Thus, the southern boundary inflow cannot be reduced while still simulating the observed pumping rates. With higher southern boundary inflows, the overall head residual increases.

Evapotranspiration

Statistics for the groundwater head calibration, discharge to the Wash, and well extraction rates are generally not sensitive to changes in ET. Given an increase in ET rates of 25%, the RM for groundwater heads is slightly less than the calibrated value; however, the RMSE for discharge to the Wash increases significantly. Conversely, a decrease in ET rates of 25% results in higher groundwater heads, but a slightly lower RMSE for discharge to the Wash (Table 8).

7. CONCEPTUAL TRANSPORT MODEL

The model is designed to include all potential source areas of perchlorate and other NERT COPCs, so that the model can be used to better understand the relative contribution of different source areas to discharges into the Las Vegas Wash and impacts to other receptors. The current version of the model focuses on perchlorate transport, but a future version will also include other major NERT COPCs.

A conceptual description of perchlorate fate and transport and a conceptual mass balance are provided in the following sections. The description of perchlorate fate and transport focuses on the NERT perchlorate plume investigated as part of the NERT RI. However, the conceptual perchlorate mass balance includes both the AMPAC and NERT plumes.

7.1 Perchlorate Fate and Transport at the Site

Perchlorate concentrations within the core of the NERT plume in the RI Study Area groundwater have been declining very slowly with intermittent rebounding episodes despite active pump and treat remediation for over three decades (Ramboll 2018c). As discussed in the Phase 1 Remedial Investigation Data Evaluation Technical Memorandum (Ramboll Environ 2016c), perchlorate present in the UMCf is likely migrating upwards into the alluvium as a result of back diffusion and upward flow caused by a natural upward vertical gradient. This is suspected to be the primary reason for the persistently elevated concentrations of perchlorate in several monitoring wells in the downgradient area of the NERT site. The forthcoming RI reports will describe the effects of back diffusion and upward flow in more detail.

Typically, diffusion rates are relatively low compared with groundwater flow rates and, as a result, the effects of diffusion are usually insignificant (as compared to advection) at the scale of site characterization and remediation activities. However, diffusion can be significant when groundwater flow rates are very low (due to low conductivities) and concentration differences exist for long periods of time. Back diffusion has been identified as a significant process controlling the time required to remediate dissolved plumes at complex sites (NRC 2013). Historically, when site discharges containing high concentrations of perchlorate were migrating downgradient in the alluvium, vertical transport from the alluvium to the UMCf would have occurred creating a significant mass of perchlorate in the uppermost reaches of the UMCf. As perchlorate concentrations in the overlying alluvium decreased with the onset of pumping activities and natural flushing, perchlorate mass that accumulated in the UMCf would migrate upward from the UMCf into the alluvium via back diffusion and upward groundwater flow.

These very slow declines of perchlorate concentrations are consistent with the UMCf acting as an on-going source of perchlorate to the alluvium. In some areas, upward vertical hydraulic gradients have been observed and are thought to be causing upward flow of groundwater and perchlorate transport from the UMCf to the alluvium. Since the low vertical hydraulic conductivity of the UMCf-fg limits the vertical flow rates, back diffusion is likely causing significant long-term transport of perchlorate from the UMCf to the alluvium and the effects of back diffusion are likely to be significant within the model area. A more detailed description of conceptual perchlorate fate and transport has been provided in the Phase 5 Model documentation (Ramboll Environ 2016a).

7.2 Fate and Transport Processes

Based on the conceptual model for the site, advection and dispersion are prominent transport mechanisms at the site. As perchlorate is a highly conservative tracer in the soils of the contaminated area and in-situ biodegradation is limited by the absence of an electron donor (i.e., carbon source), adsorption and biodegradation are negligible components in the transport model. Density-driven flow has been evaluated for incorporation into the Phase 6 transport model. As stated above, matrix diffusion is important process in order to simulate recent conditions at the site. In the Phase 6 Model, matrix diffusion is simulated using the dual domain approach. The density-driven evaluation and dual-domain approach are described below.

<u>Density-Driven Flow Evaluation</u>

The density of groundwater is increased in areas with high total dissolved solids (TDS) concentrations, which induces groundwater flow from high density areas to lower density areas. This transport process was likely relevant in areas that historically had high TDS. A separate evaluation of density-driven flow is presented in Appendix A. It is clear from the evaluation that the concentrations have to be greater than 20,000 milligrams per liter (mg/L) for the density effect to be significant. There are limited areas within the model with high enough TDS concentrations for density effects to be significant. In general, density effects do not need to be considered, since density-driven flow does not appear to be the dominant transport process under current conditions. More details are provided in Appendix A.

<u>Dual-Domain Approach</u>

Diffusion is the transport of chemicals due to concentration differences between regions (e.g., the alluvium and UMCf). Accurate simulation of diffusion typically requires a very fine discretization, which is not feasible for regional-scale models. An alternative approach is the dual-domain mass transfer method, which offers a practical solution to modeling perchlorate fate and transport for a geologically complex system like NERT study area, where small-scale preferential flow pathways cannot be fully and explicitly represented by the spatial discretization of the numerical regional model. Hence, for the current model, the dual porosity, mass transfer approach is used to represent back diffusion from the low conductivity UMCf.

7.3 Conceptual Perchlorate Mass Balance

A quarterly conceptual perchlorate mass removal was estimated for the model area for the period 2014-2018. There are three primary components of the perchlorate mass removal. The first component is perchlorate mass discharge to the Wash. This component is estimated based on an evaluation of perchlorate sampling for surface water at various locations in the Wash, paired with the corresponding instantaneous surface water flows from the nearest USGS gage station at the sampling time (see Section 3.2.1). The other two mass removal components within the model domain are the mass removal through extraction wells and the mass discharge through the storm drains, subdrains, and the mass leaving the model domain at the eastern boundary. The overall summary of the reported mass removal is provided in Table 9 and Figure 7-1.

7.3.1 Perchlorate Loading in the Las Vegas Wash

Quarterly perchlorate mass discharge to the Wash was estimated for each of the stream reaches for the period 2014-2018, as described in Section 3.2.1 and Table 1. The average total perchlorate mass discharge, estimated from groundwater discharge to the

Wash within the model boundary for the period 2014-2018, ranges from 50 pounds per day (lbs/d) (in 2018Q2) to 89 lbs/d (in 2015Q4), with an average of 75 lbs/d across the simulation period. Annual averages were 73 lbs/d in 2014, 79 lbs/d in 2015, 83 lbs/d in 2016, 76 lbs/d in 2017 and 62 lbs/d in 2018 (Table 9).

7.3.2 Perchlorate Mass Removal through the Extraction Wells

Perchlorate mass removed via the NERT extraction well fields (IWF, AWF and SWF) has been estimated using the monthly mass removal values previously reported within the annual remedial performance reports (Ramboll Environ 2014, 2015, 2016b; Ramboll 2017, 2018c, 2019b). Monthly values were aggregated to quarterly averages across the simulation period.

The average mass removal for the IWF was 598 lbs/d, with a minimum of 384 lbs/d in 2018Q3, and a maximum of 899 lbs/d in 2014Q1. For the AWF, the average across the simulation period was 470 lbs/d, with a minimum of 401 lbs/d in 2016Q2, and a maximum of 562 lbs/d in 2015Q2. For the SWF, the average across the simulation period was 67 lbs/d, with a minimum of 47 lbs/d in 2014Q2, and a maximum of 87 lbs/d in 2017Q4. The cumulative average mass removal from all well fields across the simulation period is approximately 1,140 lbs/d, with an average of 52% removal from the IWF, 42% removal from the AWF, and 6% removal from the SWF (Table 9). For the AP wells, measurements for perchlorate mass removal began in 2016Q4, with an average of 85 lbs/d. The minimum removal was 28 lbs/d during 2016Q4 and the maximum of 113 lbs/d occurred during 2017Q4.

For the Endeavour wells, monthly data was compiled from the semi-annual reports and then aggregated as quarterly averages, as was done for the flow rates described in Section 2.4. The average perchlorate removal was approximately 1,120 lbs/day for the simulation period, with a minimum of 910 lbs/d in 2018Q3 and a maximum of 1,390 lbs/d in 2014Q2 (AMPAC 2014, 2015a,b; Endeavour 2016a,b, 2017a,b, 2018a,b, 2019a).

Perchlorate removal via OSSM and TIMET wells are not reported in the monitoring reports; however, it is expected that these wells remove a negligible amount of perchlorate from the system. Since TIMET and OSSM are not treating extracted water for perchlorate, any removed perchlorate mass will be injected back in the system via their respective recharge trenches and therefore the mass removed from each of the TIMET and OSSM systems has been assumed to be 0 lbs/d for the conceptual summary (Table 9).

7.3.3 Perchlorate Discharge through the Athens Drainage Channel

Perchlorate discharge from the AMPAC plume through the Athens Drainage Channel (ADC-Main) is directly reported in the semi-annual performance monitoring reports provided by AMPAC and Endeavour (AMPAC 2014, 2015a,b; Endeavour 2016a,b, 2017a,b, 2018a,b, 2019a). The average perchlorate discharge via ADC was 14 lbs/d across the simulation period. The minimum removal of 8 lbs/d occurred during 2014Q4 and the maximum of 22 lbs/d was during 2017Q4 (Table 9).

As described in Section 3.4, the flow of the ADC channel was applied as focused recharge near the Wash as shown on Figures C1 to C5 (Appendix C). Using the similar approach, the perchlorate discharge from the channel is also applied near the Wash as concentrations in the recharge package. The total perchlorate discharge for each quarter is divided by the recharge area and has been applied as concentrations in the recharge package. Overall, the net perchlorate mass removed via the ADC channel is negligible.

7.3.4 Perchlorate Discharge through Weston Hills and Tuscany Sub-Drains

As described in Section 3.4, groundwater discharge through the Golf Course subdrains near the Wash is approximately 50 gpm (9,600 cfd). The perchlorate concentration in the outflow from these subdrains has been sampled monthly starting in October 2018 and continuing through July 2019 (Ramboll 2018b). The average concentration from these samples was approximately 2.34 mg/L. This results in a perchlorate mass removal of approximately 1.4 lbs/day, which was summarized as the estimated discharge for each quarter within the simulation period (Table 9). Using the same approach used for the ADC channel, the perchlorate mass removed via sub-drains is injected back in the model (at the discharge location near the Wash) using the recharge package. Hence, the net perchlorate mass removed via sub-drains in the simulation period is negligible.

For the Weston Hills subdrains, a surface discharge location has not been identified. It is possible that the discharge in these subdrains is included in the Tuscany sub-drains discharge location.

7.3.5 Perchlorate Discharge through the Eastern Boundary

The groundwater discharge leaving the model domain at the eastern boundary has been estimated as 25,000 cfd (see Section 3.6). There are two wells near this location, one that is north of the Wash (WMW3.5N) and one that is south of the Wash (WMW3.5S). Perchlorate sampling data is available at both locations starting in 2015 and continuing through 2018. For 2014, we have estimated the perchlorate concentrations using the respective quarterly averages for both locations, from 2015 through 2018. Quarterly average perchlorate concentrations were then multiplied by the estimated groundwater discharge rate to provide an estimate of perchlorate mass discharge through the eastern boundary, leaving the model domain. Quarterly averages are presented in Table 9 and the annual averages are 2.2 lbs/d for years 2014, 2016 and 2017. In 2015, the annual average was slightly higher, at 2.4 lbs/d and in 2018 it was slightly lower, at 2.1 lbs/d.

8. TRANSPORT MODEL DEVELOPMENT

The approach for the perchlorate fate and transport and the conceptual mass balance presented in Section 7 was used as the basis for the development of the transport model. The key transport model components are described in the following sections.

8.1 Transport Model Code

The transport model was developed using the MT3D-USGS, which is an updated version of the groundwater solute transport code MT3DMS. This code includes refined transport modeling capabilities to accommodate flow terms calculated by MODFLOW packages that were previously unsupported by MT3DMS (Bedekar et al. 2016). In particular, the MT3D-USGS code is able to simulate perchlorate fluxes to the Wash resulting from groundwater discharge. The MT3D-USGS also includes the capability to route a solute through dry cells that may occur in the Newton-Raphson formulation of MODFLOW (that is, MODFLOW-NWT) (Bedekar et al. 2016). The latest code received via email from the author is included in Appendix J.

8.2 Transport Model Simulation Period

Consistent with the flow model, the transport model simulates 1825.5 days over the period 2014-2018. The first half-day of the simulation is a steady-state stress period, followed by 1,825 days of transient simulation with a stress period for each quarter from 2014 to 2018.

8.3 Transport Model Calibration Objectives

The transport model was calibrated using a trial-and-error approach. The model calibration objectives were as follows:

- To match the simulated mass removal from the extraction wells within 15% of the observed mass removal estimates, as given in Table 9.
- To match simulated perchlorate loading from the groundwater discharge to the Wash for each stream reach.
- To obtain a mass balance error of less than 1%.
- To match perchlorate concentration targets with a residual standard deviation to range ratio of less than 10%.
- To match the simulated perchlorate plume with the observed plume for Q2-2018.

8.4 Transport Model Components

The key transport model parameters are described in the following sub-sections.

8.4.1 Dual Domain

As described in Section 7.2, the porous medium is simulated as two distinct domains, a mobile domain where groundwater flow can occur and an immobile domain where no flow can occur, and transport can only take place through mass transfer with the mobile domain. Instead of a single “effective” porosity for each model cell, two porosities are used to characterize the porous medium: one for the mobile domain and the other for the immobile domain.

A summary of the total and immobile porosity values assigned to different layers are presented in Table 10. The total porosity values are consistent with the values used for the perchlorate mass estimates, as described in Attachment A of the 2019 Annual Performance

Report (Ramboll 2019b). The mobile porosities are kept equal to the specific yield for each layer as presented in Table 4.

8.4.2 Perchlorate Calibration Targets

For the transport model, perchlorate concentration data measured in wells were used as model calibration targets. Quarterly average groundwater perchlorate concentration data for 2014-2018 were compiled from the NERT Project Database of analytical data. There sources of data include:

- Data collected by NERT:
  - Data from the Groundwater Monitoring Program (Ramboll Environ 2014, 2015, 2016b; Ramboll 2017, 2018c, 2019b);
  - Data from RI Implementation Phase 1, RI Implementation Phase 2, RI Implementation Phase 2 Parcel AB, and RI Implementation Phase 3;
  - Data from the Unit Buildings 4 and 5 Investigation (Tetra Tech 2019c); and
  - Data from treatability studies;
    - ZVI-Enhanced In-Situ Groundwater Treatability Study (Ramboll 2018a);
    - AP Area Treatability Study (Tetra Tech 2018h);
    - Galleria Drive Bioremediation Treatability Study (Tetra Tech 2018l);
    - Groundwater Bioremediation Study (Tetra Tech 2016);
    - In Situ Chromium Treatability Study (Tetra Tech 2018e);
    - Las Vegas Wash Bioremediation Pilot Study (Tetra Tech 2017b, 2018j);
    - Seep Well Field Area Bioremediation Treatability Study (Tetra Tech 2019b);
    - Soil Flushing Treatability Study (Tetra Tech 2017a); and
    - Vacuum Enhanced Recovery Treatability Study (Tetra Tech 2018g);
- Data received from SNWA, AMPAC/Endeavour, and BMI complex parties for use in the Annual Remedial Performance Reports for Chromium and Perchlorate for the NERT Site (Ramboll Environ 2014, 2015, 2016b; Ramboll 2017, 2018c, 2019b); and
- Data provided by AECOM from the Phase 1 Groundwater Investigation.

Groundwater perchlorate concentration data from monitoring wells and artesian wells were considered as targets. Samples marked as field duplicates were not included. In total, 926 wells and 6,298 perchlorate concentration measurements were considered for the model simulation period. The measurements were averaged on a quarterly basis in order to be compared to the simulated quarterly stress periods. Altogether, 4,548 quarterly perchlorate concentration targets were used for model calibration. Weights were applied to targets using the same method as for the groundwater elevation targets as described in Section 5.2.

Transport model targets used for model calibration are tabulated in Appendix H and are shown on Figure 8-1 and Figure 8-2. Figure 8-1 represents the location of calibration target in 2014. The calibration target locations for 2018 used for the model are shown on Figure 8-2.

In addition, perchlorate loading in the Wash, mass removal through extraction wells, and the perchlorate mass discharge from the subdrains were used as qualitative calibration targets.

8.4.3 Perchlorate Initial Conditions

There are two perchlorate plumes within the model extent: the NERT plume and the AMPAC plume. For model Layers 1 through 3, the perchlorate plume presented in 2014 Annual Performance Report (Ramboll Environ 2014) was used to assign the initial concentration as shown on Figures 8-3, 8-4, and 8-5. However, the extent of the 2014 plume presented in the performance report is limited to the NERT site, the off-site RI areas, and the shallow AMPAC plume. In the source area for the AMPAC plume, the plume was interpolated based on perchlorate data presented in BCA Semi-Annual/Annual Monitoring and Performance Report (AMPAC 2015b). For the Eastside Area, the initial concentrations were assigned based on 2018 plume in the 2018 Annual Performance Report (Ramboll 2018c). For Layers 4 through 10, due to limited availability of perchlorate data, initial perchlorate concentrations from the 2018 mass estimate were used and are presented on Figures 8-6 through 8-12.

Initially, equal perchlorate concentrations were assigned in the mobile and immobile zone for each grid cell in each model layer. The concentrations in the immobile zone was adjusted during calibration. The perchlorate mass present in the immobile domain is expected to serve as the continuous source of perchlorate in the model domain. Immobile concentrations under the Wash gravels in Layer 2 were increased to three times the mobile concentrations during calibration. The UMCf-cg underneath the NERT site is expected to have higher mass in the immobile zone. Hence, in Layer 2 the concentrations in the immobile zone in the UMCf-cg were increased to seven times the mobile concentrations. Immobile concentrations within the paleochannels were adjusted during calibration and were set to 1.5 times the mobile concentrations in Layer 1. The concentrations in the immobile domain were also adjusted in Layer 7 near AMEW extraction wells for calibrating the mass removal rates.

8.4.4 Transport Parameters

A summary of the transport parameter values assigned to different geologic units in the model are shown in Table 10 and are described below:

<u>Dispersivity</u>

Due to the impracticability of measuring dispersion in the field, dispersivity values are often estimated based on plume length or distance to receptors. For the NERT plume, the location of the leading edge of the plume is unknown due to Las Vegas Wash, which intercepts the plume. For the modeling purposes, the plume length of approximately 16,000 ft is assumed which is equal to the distance of the unit buildings from the Wash.

For the Phase 6 Model, the longitudinal dispersivity was estimated based on a formula developed by using a weighted best fit of field data (Xu and Eckstein 1995). This equation is provided below:

$$a_x = 0.83[\log_{10}(L_p)]^{2.414}$$

where a_x = longitudinal dispersivity and L_p = plume length in meters.

Based on the above equation, the estimated longitudinal dispersivity is around 64 ft. A uniform value of 60 ft for the dispersivity is used throughout the model domain. The transverse dispersivity was assumed to be 10% of the longitudinal dispersivity, and the vertical dispersivity was assumed to be 1% of the longitudinal dispersivity.

Diffusion Coefficient

In an aqueous (water) solution, typical diffusion coefficients are in the range of 9.3 X 10^{-4} ft^2/d to 9.3 X10^{-5} ft^2/d. As a result, diffusion in liquids is very slow over everyday length scales and is almost always dominated by advection. However, as stated in Section 7.1, in a low conductivity geologic material like UMCf-fg, diffusion can be significant. Hence, a relatively higher value of 1.53 X 10^{-3} ft^2/day has been used in the model. This value is consistent with the value used in the University of Nevada, Las Vegas (UNLV) transport model (UNLV 2003).

Mass Transfer Coefficient

Perchlorate mass transfer from mobile to immobile zones occurs when there is a concentration gradient between the two zones. The magnitude of the exchange between the mobile and immobile domains is controlled by the mass transfer coefficient. As the mass transfer coefficient increases, the exchange between the mobile and immobile domains becomes increasingly fast and the dual-domain model functions more and more like a single-domain model whose porosity approaches the total porosity of the porous medium. On the other hand, as the mass transfer rate approaches zero, the dual-domain model becomes equivalent to a single-domain model with a porosity approaching the porosity of the mobile domain. For the current modeling work, a uniform mass transfer rate of 2.25 X 10^{-4} per day (1/d) has been used for alluvium, paleochannels, Wash gravels, and UMCf-cg. A higher value of 6.85 X 10^{-4} 1/d is used for transitional unit and the UMCf-fg.

8.4.5 Stream Boundary for Perchlorate Mass Loading

The MT3D-USGS can simulate solute mass exchange between surface water bodies that are connected to the groundwater using the Streamflow Transport (SFT) Package. The model simulates solute concentrations in stream reaches, where stream reaches are defined in the SFR package as described in Section 5.4.2. The SFT routes mass through stream networks and accounts for convergent flows, groundwater/surface water exchange, precipitation, and evaporation to and from stream surfaces, and overland runoff.

One of the inputs to the SFT package is the initial surface water concentrations of solute in each of the stream reaches. For this evaluation, the available surface water perchlorate data for 2014 was analyzed and interpolated within the Wash to get the perchlorate concentrations in each stream reach. These concentrations are then added into the input SFT file before running the final model.

One objective of the modeling is to estimate the mass flux of perchlorate from groundwater to the Wash, but it is not necessary to simulate the spatial distribution of chemical concentrations within the Wash. Hence, a uniform stream-dispersion coefficient of 9.3 X 10^6 ft^2/d was applied to each stream reach in SFT package, which is a reasonable assumption for a small stream.

8.5 Transport Model Solver

To ensure a correct solution and to minimize the global mass balance error, the finite difference solution scheme was used for the transport model (Zheng 2010). The generalized conjugate gradient (GCG) solver was used with concentration change criteria of 0.001 milligrams per cubic feet (mg/ft^3) and relaxation parameter as 1. An initial time step of 0.05 days was used for simulation.

9. TRANSPORT MODEL CALIBRATION

As described in Section 8.2, the transport model was run for 1,825.5 days to cover the period of 2014-2018.

9.1 Model Calibration

The transport model was manually calibrated to match the conceptual mass balance components for the simulation period (2014-2018). The mass transfer rate and the concentrations in the immobile zone for shallow layers were adjusted to get an acceptable match to measured mass removal rates in the extraction wells and the perchlorate loading in the Wash. The overall solute mass balance error was kept at less than 1%.

Table 11 provides a summary of target residual statistics for the 4,548 observation wells used to calibrate the Phase 6 transport model. The overall average target residual in the calibrated model is -0.57 mg/L. A negative residual value indicates that the simulated concentrations are higher than the observed values. There is a RMSE of 120.5 mg/L with the range of observation of 6,600 mg/L. The residual standard deviation of the model targets is 120.5 mg/L. A model is considered well calibrated when the ratio of the residual standard deviation to the range of observed values is less than 10 percent (Hill and Tiedeman 2007). For the Phase 6 transport model, this ratio is about 1.8% percent. The observed versus simulated concentration difference at the target locations is given in Appendix I. Residuals for each target location are shown in Table I-1 (Appendix I).

The calibration plots for each well show that there is a good fit at the vast majority of targets (Table I-1, Appendix I). Table I-1 shows the distribution of targets in the Shallow, Middle, and Deep WBZs. The match between simulated and observed concentrations appears reasonable except for results from AP Area and Soil Flushing treatability studies (Tetra Tech 2018h). The model is not expected to match these results accurately since soil flushing was not simulated in the model. Hence, for the treatability study wells, the model calibration was only focused on the baseline data points.

Figure 9-1 shows a scatter plot characterizing the match between modeled and observed groundwater perchlorate concentrations at wells used as calibration targets. The plots illustrate that there is generally good agreement between modeled and observed values, with most points falling close to the 1:1 correlation line. As stated above, for the treatability study wells, the calibration was refined to match baseline data only as shown on individual wells calibration plots in Appendix I. The "goodness-of-fit" R^2 value is 0.88, demonstrating an acceptable fit to the observed concentrations.

9.2 Sensitivity Analysis of Transport Model

A sensitivity analysis was conducted to evaluate the effect of transport model input parameter uncertainty on significant model outputs. The model input parameters evaluated included: 1) dispersivity, 2) mass transfer rate, and 3) porosity. The sensitivity analysis was performed by changing each of these model input parameters by a factor of 0.75 and 1.25, running the model, and recording the outputs of interest.

The model outputs evaluated for the sensitivity analysis are: 1) calibration statistics based on simulated perchlorate concentrations at target locations, 2) the RMSE for the total perchlorate mass loading in the wash, and 3) the RMSE for the combined mass removal from the various extraction systems. The results of the sensitivity analysis for these outputs are shown in Table 12 and described in further detail below.

Dispersivity

The dispersivity value used in the calibrated model was 60 ft. When the value was reduced by 25%, the target residual statistics for majority of model outputs decreased, except for RMSE and sum of squared residuals of perchlorate in the groundwater, which has increased slightly. The model also has higher mass balance error with the lower dispersivity value. When the dispersivity value was increased by 25%, the target residual statistics for all model outputs increased except for the RMSE for mass removal in the extraction wells.

Mass Transfer Rate

Calibrated values for the mass transfer rate ranged from 2.25 X 10^{-4} to 6.85 X 10^{-4} ft^2/d , depending on the location. By decreasing the mass transfer rate by 25%, the majority of the model output statistics increased. With an increased mass transfer rate by 25%, the statistics are general higher for all model outputs except for the RMSE for mass removal in the extraction wells, which decreased slightly.

Porosity

The calibrated values for total porosity ranged from 0.37 to 0.54, depending on the location within the model. By decreasing the porosity (both mobile and immobile) by 25%, all model output statistics has increased except for the RM for perchlorate in groundwater. By increasing the porosity (both mobile and immobile) by 25%, the model output statistics increased significantly except for the RMSE for perchlorate loading in the Wash, which decreased slightly.

9.3 Transport Model Results

The quarterly estimates of observed versus simulated mass removal rates for the model simulation period are presented on Figure 9-2. The calibration of the transport model is generally good based on a comparison of various simulated and conceptual mass balance components, mass removal at extraction wells, loading in the Wash, and the discharge in ADC Channel (Table 13).

Perchlorate Mass Loading in the Wash

The modeled versus observed perchlorate loading in the Wash at the stream gage stations is presented on Figures 9-3 through 9-7. The modeled estimates are comparable to the conceptual loading estimates at each station. However, the modeled estimated of loading in the initial time step of the model is generally lower than the conceptual estimates. The combined quarterly perchlorate loading in the Wash for the simulation period is also given in Table 13.

Perchlorate Mass Discharge in Athens Drainage Channel

The modeled versus observed perchlorate discharge in Endeavour's ADC channel is evaluated and is presented on Figure 9-8. The modeled discharge values are consistently higher by a few lbs/d as compared to the measured discharge values. The modeled discharge values are presented in Table 13.

Mass Removal Through Extraction Systems

The modeled perchlorate mass removal for each well field is evaluated and is presented in Table 13. The modeled mass removal is further compared to the measured mass removal for combined NERT and Endeavour's well field, and is presented on Figure 9-9 and Figure 9-10, respectively. The mass removal by AP wells is combined with IWF mass removal for this evaluation (Figure 9-9).

The simulated mass removal rates at AWF are slightly lower than the observed mass removal in early part of model simulation. At the SWF, the simulated mass removal rates are estimated slightly higher than the observed rates. The simulated mass removal rates at other well fields are very similar to the measured mass removal (Table 13).

Mass Discharge at the Eastern Model Boundary

The simulated groundwater perchlorate discharge leaving the model domain at the eastern boundary is approximately 2-3 lbs/d during the model simulation period (Table 13). This has been estimated based on the total simulated flow in the outflow boundary at the eastern model boundary (Figures 5-11 and 5-12) and the average simulated perchlorate concentrations in wells WMW3.5N and WMW3.5S.

Simulated Perchlorate Plume for 2018

The simulated groundwater perchlorate plume for 2018 is compared with the observed perchlorate plume presented in 2018 Annual Performance Report (Ramboll 2018c). The comparative plume is shown on Figure 9-11. The simulated plume configuration reasonably matches the observed plume.

10. CONCLUSIONS

The Phase 6 Model simulates groundwater flow and perchlorate transport for the period 2014-2018. As part of the modeling effort, a detailed quarterly conceptual water balance and perchlorate mass balance was developed that was used as the basis for estimating the inflows and outflows of groundwater and perchlorate in the model.

The three-dimensional (3D) geological model developed to support the Phase 5 groundwater model was updated with borings drilled as part of the Phase 2 and 3 RI, as well as borings associated with treatability studies, including the Seep Well Field Area Bioremediation Treatability Study, Galleria Drive Bioremediation Treatability Study, and Las Vegas Wash Bioremediation Pilot Study. The boring logs for the RI Phase 2 off-site borings and the RI Phase 3 borings were still draft at the time the geological model was developed. There may be minor changes to these contact elevations in future versions of the model. Data collected as part of investigations by other parties has been incorporated in the model as calibration targets or for the evaluation of conceptual water balance.

The capability of simulating perchlorate fate and transport component was added to the Phase 6 Model based on the MT3D-USGS code using the dual-domain approach. The dual-domain approach was found to appropriately represent the effects of matrix diffusion. The Phase 6 Model was found to generally be able to accurately estimate the perchlorate loading in the Wash and the mass removal by the existing extraction systems.

The Phase 6 Model is expected to be further revised based on data collected as part of the OU-3 RI, recent investigations in the Downgradient Study Area, and ongoing treatability studies. In addition, the next version of the model will include the simulation of other major NERT COPCs, such as chlorate, chloroform, and hexavalent chromium. In order to simulate in-situ treatment of NERT COPCs, the next version of the model will also incorporate data from treatability studies concerning the feasibility of in-situ treatment in different areas of the NERT RI Study Area.

11. REFERENCES

AECOM. 2019. Supplemental Surface Water Investigation Technical Memorandum; NERT Remedial Investigation - Downgradient Study Area; Nevada Environmental Response Trust Site; Henderson, Nevada. April 17.

AMPAC (American Pacific Corporation). 2007. Report on the One Year Performance and Operations Optimization Program of the Endeavour In Situ Bioremediation (ISB) System for Perchlorate in Groundwater at the Athens Rd/Galleria Dr Area in Henderson, Nevada. August 23.

AMPAC. 2012. BCA Semi-Annual/Annual Performance and BWPC UIC Monitoring Program; January 1 – June 30, 2012; Perchlorate In Situ Bioremediation System; American Pacific Corporation; Henderson, Nevada. August 14.

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.

AMPAC. 2015a. BCA Semi-Annual/Annual Monitoring and Performance Report; July 1 to December 31, 2014; Perchlorate Bioremediation System; American Pacific Corporation; Henderson, Nevada. February 20.

AMPAC. 2015b. BCA Semi-Annual/Annual Monitoring and Performance Report; January 1 to June 30, 2015; Perchlorate Bioremediation System; American Pacific Corporation; Henderson, Nevada. August 18.

Bedekar, V., E.D. Morway, C.D. Langevin, and M. Tonkin. 2016. MT3D-USGS version 1.0.0: Groundwater Solute Transport Simulator for MODFLOW: U.S. Geological Survey Software Release. September 30. http://dx.doi.org/10.5066/F75T3HKD

Bell J. and E. Smith. 1980. Geologic Map of the Henderson Quadrangle. Nevada Bureau of Mines and Geology, University of Nevada, Reno.

Bingler. 1977. Geological Map of the Las Vegas SE Quadrangle. Nevada Bureau of Mines and Geology, University of Nevada, Reno.

BRC (Basic Remediation Company). 2007. Conceptual Site Model Proposed CAMU Site, Henderson, Nevada, Submitted to Nevada Department of Environmental Protection, February 16.

BRC. 2009. Summary Report for Updated Groundwater Flow Model Calibration, BMI Upper and Lower Ponds Area, Submitted to NDEP. November 2.

CCDAQEM (Clark County Department of Air Quality and Environmental Management). 2009. Clark County 208, Area-Wide Water Quality Management Plan. March.

Converse (Converse Consultants). 1998a. Subdrain Design Recommendations; Palm City Residential Development; Lake Mead Boulevard; Henderson, Nevada. Submitted to Rhodes Homes. February 6.

Converse. 1998b. Infiltration Subdrain Design Recommendations; Palm City Residential Development; Lake Mead Drive and Future Sunset Road; Henderson, Nevada. Submitted to Rhodes Homes. November 11.

de maximis (de maximis, inc.). 2014. Semi-Annual Operations Report; Groundwater Treatment System; Henderson, Nevada; January – June 2014. August 15.

de maximis. 2015a. Semi-Annual Operations Report; Groundwater Treatment System; Henderson, Nevada; July – December 2014. February 15.

de maximis. 2015b. Semi-Annual Operations Report; Groundwater Treatment System; Henderson, Nevada; January – June 2015. August 15.

de maximis. 2016a. Semi-Annual Operations Report; Groundwater Treatment System; Henderson, Nevada; July – December 2015. February 15.

de maximis. 2016b. Semi-Annual Operations Report; Groundwater Treatment System; Henderson, Nevada; January – June 2016. August 15.

de maximis. 2017a. Semi-Annual Operations Report; Groundwater Treatment System; Henderson, Nevada; July – December 2016. February 15.

de maximis. 2017b. Semi-Annual Operations Report; Groundwater Treatment System; Henderson, Nevada; January – June 2017. August 15.

de maximis. 2018a. Semi-Annual Operations Report; Groundwater Treatment System; Henderson, Nevada; July – December 2017. February 15.

de maximis. 2018b. Semi-Annual Operations Report; Groundwater Treatment System; Henderson, Nevada; January – June 2018. August 15.

de maximis. 2019. Semi-Annual Operations Report; Groundwater Treatment System; Henderson, Nevada; July – December 2018. February 15.

Donovan, D.J. and T. Katzer. 2000. Hydrogeologic Implications of Greater Ground-Water Recharge to Las Vegas Valley, Nevada. *Journal of the American Water Resources Association* 36(5):1133-1148.

Donovan, D.J., T. Katzer, and K. Brothers. 2009. Review of Ground-Water Recharge Estimates in Nevada with an Analysis of Geologic Control on the Recharge Process, Nevada. Southern Nevada Water Authority. https://aquaterranova.files.wordpress.com/2014/09/2009-review-of-ground-water-recharge-estimates.pdf

Endeavour (Endeavour, LLC). 2016a. BISC Semi-Annual/Annual Monitoring and Performance Report; July 1 to December 31, 2015; Perchlorate Bioremediation System; Endeavour, LLC; Henderson, Nevada. February 15.

Endeavour. 2016b. BISC Semi-Annual/Annual Monitoring and Performance Report; January 1 to June 30, 2016; Perchlorate Bioremediation System; Endeavour, LLC; Henderson, Nevada. August 11.

Endeavour. 2017a. BISC Semi-Annual/Annual Monitoring and Performance Report; July 1 to December 31, 2016; Perchlorate Bioremediation System; Endeavour, LLC; Henderson, Nevada. February 14.

Endeavour. 2017b. BISC Semi-Annual/Annual Monitoring and Performance Report, Rev.1; January 1 to June 30, 2017; Perchlorate Bioremediation System; Endeavour, LLC; Henderson, Nevada. August 14. Revised September 20.

Endeavour. 2018a. BISC Semi-Annual Monitoring and Performance Report, Rev. 1; July 1 – December 31, 2017; Perchlorate Bioremediation System; Endeavour, LLC; Henderson, Nevada. February 14. Revised February 28.

Endeavour. 2018b. BISC Semi-Annual/Annual Monitoring and Performance Report, Rev.1; January 1 to June 30, 2018; Perchlorate Bioremediation System; Endeavour, LLC; Henderson, Nevada. August 14. Revised September 14.

Endeavour. 2019a. BISC Semi-Annual Monitoring and Performance Report, Rev.1; July 1 – December 31, 2018; Perchlorate Bioremediation System; Endeavour, LLC; Henderson, Nevada. February 15. Revised April 22.

Endeavour. 2019b. Work Plan for Eastgate Drain Surface Water Mitigation System - For Collection and Treatment at AGTS, Perchlorate Bioremediation System; Endeavour LLC; Henderson, Nevada. August 1.

ENSR. 1999. National Pollution Discharge Elimination System, Permit Application Perchlorate Removal Action, Henderson, Nevada. ENSR Document No. 4020-011-100. September.

ENSR. 2005. Quarterly Performance Report; Perchlorate Recovery System; Kerr-McGee Chemical LLC, Henderson, Nevada. ENSR Document No. 04020-023. April.

ENSR. 2007. Phase A Source Area Investigation Results Report, Tronox LLC Facility, Henderson, Nevada. September. NDEP approved November 30, 2007.

ENVIRON (ENVIRON International Corporation). 2014a. Semi-Annual Remedial Performance Report for Chromium and Perchlorate. Nevada Environmental Response Trust Site; Henderson, Nevada; July 2013-December 2013. February 28.

ENVIRON. 2014b. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2013-June 2014. October 31.

Epstein, B. J., G.M. Pohll, J. Huntington and R.W.H. Carroll. 2010. Development and Uncertainty Analysis of an Empirical Recharge Prediction Model for Nevada's Desert Basins. *Journal of the Nevada Water Resources Association*. Summer 2010.

GEI (GEI Consultants, Inc.). 2014. Titanium Metals Corporation, Henderson, Nevada Facility, Facility ID# H000537, Quarterly Status Report for the 4th Quarter of 2013. January 15.

GEI. 2019. Groundwater Extraction and Treatment System Operations, Maintenance and Performance Report; Fourth Quarter 2018. February 28.

Geosyntec (Geosyntec Consultants). 2010. Groundwater Flow Model, South of Warm Springs Study Area; Henderson, Nevada; Prepared for American Pacific Corporation. February 3.

Geosyntec. 2013. Transient Calibration of Groundwater Flow Model South of Warm Springs Study Area Henderson, Nevada. June 28.

Geosyntec. 2016. Groundwater Flow Model Update, Henderson, Nevada. September 13.

Geosyntec. 2017. Shallow Zone Capture Assessment – Revision 1, Endeavour, Henderson, Nevada. March 23.

GES (Geotechnical & Environmental Services, Inc.). 2003. Geotechnical Investigation Demonstration Weir W-3.9 Replacement SNWA Contract No. 810-K, Las Vegas Wash Erosion Control Program, Clark County, Nevada, File No. 20031518E1. August 8.

GES. 2007. Deep Background Investigation Report. November 19.

Geovision (Geovision Geophysical Service). 2003a. Draft Interim Report, Geophysical Investigation; BMI Upper and Lower Ponds and Ditches; Clark County, Nevada. May 1.

Geovision. 2003b. Preliminary Draft Report, Geophysical Investigation; Las Vegas Wash; Clark County, Nevada. May 1.

Hanson, R.T., S.E. Boyce, Schmid, Wolfgang, J.D. Hughes, S.M. Mehl, S.A. Leake, Maddock, Thomas, III and R.G. Niswonger. 2014. One-Water Hydrologic Flow Model (MODFLOW-OWHM): U.S. Geological Survey Techniques and Methods 6–A51. http://dx.doi.org/10.3133/tm6A51.

Hargis (Hargis+Associates, Inc.). 2008. Conceptual Site Model Former Montrose and Stauffer Facilities and Downgradient Areas to Las Vegas Wash, Henderson, Clark County, Nevada. July 25.

Hargis. 2012. 2012 Comprehensive Groundwater Data Evaluation Report; Former Montrose and Stauffer Facilities and Current Olin Facility; Henderson, Nevada. August 16.

Hill, M.C. and C.R. Tiedeman. 2007. *Effective Groundwater Model Calibration: With Analysis of Data, Sensitivities, Predictions, and Uncertainty*. John Wiley & Sons, Inc.

Kerr-McGee. 2000. Semi-Annual Chromium Mitigation Performance Report, Kerr-McGee Chemical LLC, Henderson, Nevada, January 26.

Kerr-McGee. 2001. Semi-Annual Performance Report; Chromium Mitigation Program. July 27.

Kleinfelder. 2005. Hydrogeologic Investigation – 2004 Phase III Drilling and Aquifer Testing; American Pacific Corporation, Henderson, Nevada. January 11.

Konikow, L.F., G.Z. Hornberger, K.J. Halford and R.T. Hanson. 2009. Revised multi-node well (MNW2) package for MODFLOW ground-water flow model: U.S. Geological Survey Techniques and Methods 6–A30.

LVWCC (Las Vegas Wash Coordination Committee). 2019. Year-End Report, 2018. April. https://www.lvwash.org/assets/pdf/resources_lvwcc_2018.pdf

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.

McGinley (McGinley & Associates). 2003. Las Vegas Wash Initial Perchlorate Modeling Report, Las Vegas Wash; Henderson, Nevada; Prepared for Nevada Division of Environmental Protection. October 20.

McGinley. 2007. Athens Road Well Field Modeling Report, Near BMI Industrial Complex; Henderson, Nevada; Prepared for Nevada Division of Environmental Protection. June 30.

NRC (National Research Council). 2013. *Alternatives for Managing the Nation's Complex Contaminated Groundwater Sites*. National Academies Press: Washington DC.

NDEP (Nevada Division of Environmental Protection). 2003. Las Vegas Wash Initial Perchlorate Modeling Report, Las Vegas Wash; Henderson, Nevada. October 20.

NDEP. 2009. Letter Re: BMI Plant Sites and Common Area Projects, Henderson, Nevada; Hydrogeologic and Lithologic Nomenclature Unification. January 6.

NDEP. 2017. Response to: Phase 5 Transient Groundwater Flow Model, Response to Comments, Nevada Environmental Response Trust, Henderson, Nevada. June 26.

Niswonger, R.G., Panday, Sorab, and M. Ibaraki. 2011. MODFLOW-NWT, A Newton formulation for MODFLOW-2005: U.S. Geological Survey Techniques and Methods 6–A37.

Northgate (Northgate Environmental Management, Inc.). 2010. Capture Zone Evaluation Report; Tronox LLC; Henderson, Nevada. December 3.

PRISM (PRISM Climate Group). 2013. Gridded Climate Data for the Contiguous USA. http://prism.oregonstate.edu.

Ramboll Environ (Ramboll Environ US Corporation). 2014. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2013-June 2014. October 31. NDEP approved December 26.

Ramboll Environ. 2015. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2014-June 2015. October 29. NDEP approved December 30.

Ramboll Environ. 2016a. Phase 5 Transient Groundwater Flow Model – Nevada Environmental Response Trust Site; Henderson, Nevada. November 15. NDEP approved June 26, 2017.

Ramboll Environ. 2016b. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2015-June 2016. October 31. NDEP approved December 6.

Ramboll Environ. 2016c. Technical Memorandum, Remedial Investigation Data Evaluation, Nevada Environmental Response Trust Site; Henderson, Nevada. May 2. NDEP approved July 13.

Ramboll Environ. 2017. RI Study Area Mass Estimate and Expanded Performance Metrics Technical Approach, Nevada Environmental Response Trust Site; Henderson, Nevada. October 5. NDEP approved October 19, 2017.

Ramboll (Ramboll US Corporation). 2017. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2016-June 2017. December 8. NDEP approved February 6, 2018.

Ramboll. 2018a. Technical Memorandum, Treatability/Pilot Study Modification No. 5, Nevada Environmental Response Trust Site; Henderson, Nevada. November 5. NDEP approved November 14.

Ramboll. 2018b. RI Phase 3 Modification No. 2, Nevada Environmental Response Trust Site; Henderson, Nevada. Ramboll Project no. 1690006943-036. April 10. NDEP approved April 12.

Ramboll. 2018c. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2017-June 2018. November 9. NDEP approved January 18, 2019.

Ramboll. 2019a. Barrier Wall Integrity Evaluation Report, Nevada Environmental Response Trust Site; Henderson, Nevada. August 30. Revised November 21.

Ramboll. 2019b. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2018–June 2019. In progress.

Sanford, W.E. and D.L. Selnick. 2012. Estimation of Evapotranspiration Across the Conterminous Unites States using a Regression with Climate and Land-Cover Data. *Journal of the American Water Resources Association* 49(1): 217-230.

Tetra Tech (Tetra Tech, Inc.). 2016. Groundwater Bioremediation Treatability Study Results Report; Nevada Environmental Response Trust Site; Henderson, Nevada. November 25.

Tetra Tech. 2017a. Soil Flushing Treatability Study Report; Nevada Environmental Response Trust Site; Henderson, Nevada. July 3.

Tetra Tech. 2017b. Las Vegas Wash Bioremediation Pilot Study Work Plan; Nevada Environmental Response Trust Site; Henderson, Nevada. September 22.

Tetra Tech. 2018a. Operation and Maintenance Summary – January 2018 Weir Dewatering Treatment Plant. February 28.

Tetra Tech. 2018b. Operation and Maintenance Summary – February 2018 Weir Dewatering Treatment Plant. March 23.

Tetra Tech. 2018c. Operation and Maintenance Summary – March 2018 Weir Dewatering Treatment Plant. April 20.

Tetra Tech. 2018d. Operation and Maintenance Summary – April 2018 Weir Dewatering Treatment Plant. May 22.

Tetra Tech. 2018e. In-Situ Chromium Treatability Study Results Report; Nevada Environmental Response Trust Site; Henderson, Nevada. June 22.

Tetra Tech. 2018f. Operation and Maintenance Summary – May 2018 Weir Dewatering Treatment Plant. June 22

Tetra Tech. 2018g. Vacuum Enhanced Recovery Treatability Study Results Report; Nevada Environmental Response Trust Site; Henderson, Nevada. July 12.

Tetra Tech. 2018h. AP Area Down and Up Flushing Treatability Study Results Report, Nevada Environmental Response Trust Site, Henderson, July 27.

Tetra Tech. 2018i. Operation and Maintenance Summary – June 2018 Weir Dewatering Treatment Plant. July 31.

Tetra Tech. 2018j. Treatability/Pilot Study Modification No. 2 – Las Vegas Wash Bioremediation Pilot Study; Nevada Environmental Response Trust Site; Henderson, Nevada. August 17.

Tetra Tech. 2018k. Operation and Maintenance Summary – July 2018 Weir Dewatering Treatment Plant. August 20.

Tetra Tech. 2018l. Treatability/Pilot Study Modification No.3, Revision 1 – Galleria Road Bioremediation Treatability Study; Nevada Environmental Response Trust Site; Henderson, Nevada. August 29.

Tetra Tech. 2018m. Operation and Maintenance Summary – August 2018 Weir Dewatering Treatment Plant. September 20.

Tetra Tech. 2018n. Operation and Maintenance Summary – September 2018 Weir Dewatering Treatment Plant. November 5.

Tetra Tech. 2018o. Operation and Maintenance Summary – October 2018 Weir Dewatering Treatment Plant. December 3.

Tetra Tech. 2018p. Operation and Maintenance Summary – November 2018 Weir Dewatering Treatment Plant. December 27.

Tetra Tech. 2019a. Operation and Maintenance Summary – December 2018 Weir Dewatering Treatment Plant. January 21.

Tetra Tech. 2019b. Seep Well Field Area Bioremediation Treatability Study Results Report; Nevada Environmental Response Trust Site; Henderson, Nevada. August 13.

Tetra Tech. 2019c. Unit 4 and 5 Buildings Investigation Source Area Characterization Report; Nevada Environmental Response Trust Site; Henderson, Nevada. August 29.

TIMET (Titanium Metals Corporation Facility). 2008. Semiannual Groundwater Monitoring Report, 2nd Semester 2008; Titanium Metals Corporation Facility; Henderson, Nevada. October 31.

Todd, D.K. 1980. *Groundwater Hydrology*, 2nd ed., New York: John Wiley & Sons.

UNLV (University of Nevada, Las Vegas). 2003. Fate and Transport of Perchlorate in a Contaminated Site in the Las Vegas Valley. Prepared for USEPA.

USGS (United States Geological Survey). 1989. Groundwater Conditions in Las Vegas Valley, Clark County, Nevada, Part 1, Hydrogeologic Framework; United States Geological Survey Water-Supply Paper 2320-A.

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.

USGS. 1997. Preliminary Location and Geometry of the Las Vegas Valley Shear Zone Based on Gravity and Aeromagnetic Data. Open-File Report 97-441.

USGS. 2004a. Groundwater Pumpage and Artificial Recharge Estimates for Calendar Year 2000 and Average Annual Natural Recharge and Interbasin Flow by Hydrographic Area, Nevada; United States Geological Survey Scientific Investigation Report 2004-5239.

USGS. 2004b. A New Streamflow-Routing (SFR1) Package to Simulate Stream-Aquifer Interaction with Modflow-2000; United States Geological Survey Open-File Report 2004-1042.

USGS. 2005. Geologic and Geophysical Maps of the Las Vegas 30' X 60' Quadrangle, Clark and Nye Counties, Nevada, and Inyo County, California; United States Geological Survey - Pamphlet to accompany Scientific Investigations Map 2814.

USGS. 2008. Quantifying Ground-Water and Surface-Water Discharge from Evapotranspiration Processes in 12 Hydrographic Areas of the Colorado Regional Ground-Water Flow System, Nevada, Utah, and Arizona; United States Geological Survey Scientific Investigation Report 2008–5116.

Vector (Vector Engineering Inc.). 2011. Laboratory Services, Soil – Bentonite, Backfill Mix Design Henderson Slurry Wall, Nevada. April 12.

Xu, M. and Y. Eckstein. 1995. Use of weighted least-squares method in evaluation of the relationship between dispersivity and field scale. *Groundwater* 33(6): 905-90.

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

TABLES

TABLE 1. ESTIMATED PERCHLORATE MASS DISCHARGE TO LAS VEGAS WASH
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Year	Quarter	Mass Loading Measured at Las Vegas Wasteway	Perchlorate Mass Discharge (lbs/d)						Mass Loading Measured At Three Kids[f]	Mass Loading Measured At Northshore Road
			Reach 1 (Las Vegas Wasteway to Duck Creek Confluence)[a]	Reach 2 (Duck Creek Confluence to Pabco Road)[b,c]	Reach 3 (Pabco Road to Bostic Weir)[c,d,e,f]	Reach 4 (Bostic Weir to Homestead Weir)[b,e,f]	Reach 5 (Homestead Weir to Three Kids)[e,f]	Total from Reach 1 to Reach 5[f]		
2014	Q1	2.0	0.6	28	1.0	27	23	79	81	82
	Q2	1.2	0.5	20	1.1	31	26	78	79	77
	Q3	1.2	0.4	18	0.9	26	22	67	68	73
	Q4	1.2	0.4	18	1.0	27	23	69	71	72
2015	Q1	2.0	0.2	10	1.3	36	31	79	81	80
	Q2	1.1	0.6	27	0.8	23	19	70	71	71
	Q3	1.3	0.4	19	1.1	31	26	78	79	70
	Q4	1.2	0.4	18	1.4	38	32	89	147	91
2016	Q1	1.9	0.4	19	1.3	36	30	86	124	88
	Q2	1.1	0.4	20	1.2	34	29	84	109	85
	Q3	1.2	0.4	19	1.2	33	28	81	107	82
	Q4	1.1	0.4	16	1.2	34	29	81	100	82
2017	Q1	1.7	0.0	20 [14]	1.4 [3]	31 [17]	35 [24]	88	90	77
	Q2	1.0	0.01	17	0.0	31	28	76	77	66
	Q3	1.2	1.0	14	0.0	29	20	65	65	63
	Q4	0.9	0.4	16	3.6	33	24	77	78	79
2018	Q1	1.4	0.05	4	11	30	28	73	75	62
	Q2	1.3	0.0	1 [1]	2 [3]	27 [27]	19 [12]	49	51	61
	Q3	1.0	0.1	5	6	34	13	57	59	64
	Q4	0.8	0.4	20	4	30	14	68	69	65

Notes:

lbs/d = pounds per day

[#] = Mass discharge reported by AECOM, Supplemental Surface Water Investigation Technical Memorandum (2019).

[a] = Discharge data were not available for Las Vegas Wasteway from January 2016 through February 2017, and there was only one sample available for 1Q of 2017. The average of 1Q from 2015 and 2018 was used to estimate the loading for 1Q 2017 and then the average quarterly loadings from 2015 and 2017 were used to estimate the loadings for all quarters in 2016, respectively.

[b] = Measurements were not available for 2014 through 2016 for the Duck Creek Confluence, Bostic Weir and Homestead Weir stations. Loading for these locations was estimated using the average distribution of loading for each sub-reach in 2017.

[c] = Loading values at Pabco Road reflect the quarterly averages as they have been reported by Ramboll in the Semi-annual and Annual Remedial Performance Reports.

[d] = The loading for 3Q 2017 was slightly higher at Bostic Weir than the loading estimated at Pabco Road. To avoid a negative loading value (-1 lb/d), this value was adjusted to zero.

[e] = Loading data became available for the Bostic and Homestead gages at the end of June 2017. The average loading from 3Q-4Q 2017 was instead used to estimate the loading for 2Q of 2017. For 1Q of 2017 at these locations, the loading was estimated as the average of 4Q in 2017 and 2018, to reflect the similar seasonal conditions in the winter.

[f] = At the Three Kids location, perchlorate concentrations and streamflows were abnormally high between 4Q 2015 through 4Q 2016. During this time period, the average loading measured between Pabco Road and Northshore Road has been used in place of the loading between Pabco Road and Three Kids. The loading for Reach B was then distributed to the sub-reaches according to the average distribution in 2017 for loading between Pabco Road and Three Kids.

TABLE 2a. GROUNDWATER DISCHARGE TO LAS VEGAS WASH BASED ON CHEMISTRY AND FLOW DATA
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Parameter	2014					2015					2016					2017					2018				
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5
	Las Vegas Wasteway to Duck Creek Confluence	Duck Creek Confluence to Pabco Road	Pabco Road to Bostic Weir	Bostic Weir to Homestead Weir	Homestead to Three Kids	Las Vegas Wasteway to Duck Creek Confluence	Duck Creek Confluence to Pabco Road	Pabco Road to Bostic Weir	Bostic Weir to Homestead Weir	Homestead to Three Kids	Las Vegas Wasteway to Duck Creek Confluence	Duck Creek Confluence to Pabco Road	Pabco Road to Bostic Weir	Bostic Weir to Homestead Weir	Homestead to Three Kids	Las Vegas Wasteway to Duck Creek Confluence	Duck Creek Confluence to Pabco Road	Pabco Road to Bostic Weir	Bostic Weir to Homestead Weir	Homestead to Three Kids	Las Vegas Wasteway to Duck Creek Confluence	Duck Creek Confluence to Pabco Road	Pabco Road to Bostic Weir	Bostic Weir to Homestead Weir	Homestead to Three Kids
Change in Perchlorate Mass Loading Within Reach (lbs/d)	0.48	21.06	1.00	27.62	23.28	0.43	18.71	1.08	29.98	25.27	0.42	18.40	1.08	29.98	25.27	0.35	16.93	1.20	31.23	26.76	0.14	7.50	5.85	30.18	18.47
Perchlorate Concentration in Groundwater Near Reach (µg/l)[a]	86	1,800	4,800	2,000	1,500	100	3,400	3,300	1,900	1,500	72	3,200	3,200	1,900	1,400	120	2,600	2,350	1,880	1,700	120	2,800	9,410	1,700	1,600
Estimated Groundwater Inflow Rate Based on Mass Balance (cfs)	1.04	2.17	0.04	2.57	2.88	0.79	1.02	0.06	2.93	3.13	1.08	1.07	0.06	2.93	3.35	0.54	1.21	0.09	3.09	2.93	0.22	0.50	0.12	3.30	2.15
Proportion of Reach Within Model Domain	60%	100%	100%	100%	100%	60%	100%	100%	100%	100%	60%	100%	100%	100%	100%	60%	100%	100%	100%	100%	60%	100%	100%	100%	100%
Net Groundwater Inflow Rate (cfs)	**0.62**	**2.17**	**0.04**	**2.57**	**2.88**	**0.48**	**1.02**	**0.06**	**2.93**	**3.13**	**0.65**	**1.07**	**0.06**	**2.93**	**3.35**	**0.32**	**1.21**	**0.09**	**3.09**	**2.93**	**0.13**	**0.50**	**0.12**	**3.30**	**2.15**
Net Groundwater Inflow Rate (cfd)	**53,800**	**188,000**	**3,330**	**222,000**	**249,000**	**41,100**	**88,300**	**5,260**	**253,000**	**270,000**	**56,100**	**92,300**	**5,420**	**253,000**	**290,000**	**27,800**	**105,000**	**8,210**	**267,000**	**253,000**	**11,200**	**43,000**	**9,990**	**285,000**	**185,000**
Net Groundwater Inflow Rate, Reach 1 through 5 Combined (cfd)	**720,000**					**660,000**					**700,000**					**660,000**					**530,000**				

Notes:
cfd = cubic feet per day
cfs = cubic feet per second
lbs/d = pounds per day
µg/l = micrograms per liter
[1] The average perchlorate loading at LV Wasteway Station for 2017 is 1.02 lbs/day. To get perchloate loading in Reach 1, the 1.9 lbs/d measured at the Duck Creek Confleunce is subtracted form the LV wasteway station.
[a] Perchlorate concentrations are calculated using well sampling data in the second quarter of each year. Wells are selected using a 300 foot buffer zone to the south of the Las Vegas Wash, except for Reach 1, where well PMW-8 is selected.
Net combined groundwater inflow rate rounded to two significant figures after calculating.

TABLE 2b. ESTIMATED WATER BALANCE IN LAS VEGAS WASH
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Flow Component	2014					2015					2016					2017					2018				
	Duck Creek Confluence	Pabco Road	Bostic	Homestead	Three Kids	Duck Creek Confluence	Pabco Road	Bostic	Homestead	Three Kids	Duck Creek Confluence	Pabco Road	Bostic	Homestead	Three Kids	Duck Creek Confluence	Pabco Road	Bostic	Homestead	Three Kids	Duck Creek Confluence	Pabco Road	Bostic	Homestead	Three Kids
Inflow from Las Vegas Wasteway (cfs)	254.79	--	--	--	--	254.46	--	--	--	--	NA	--	--	--	--	248.12	--	--	--	--	254.46	--	--	--	--
Inflow from Duck Creek Confluence (cfs)	7.54	--	--	--	--	10.19	--	--	--	--	11.79	--	--	--	--	10.36	--	--	--	--	10.81	--	--	--	--
Total Upstream Inflow (cfs)	262.33	--	--	--	--	264.65	--	--	--	--	264.65	--	--	--	--	258.48	--	--	--	--	265.27	--	--	--	--
Effluent Discharge (cfs):	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
COH Wastewater Outfall	--	19.76	--	--	--	--	21.45	--	--	--	--	21.21	--	--	--	--	21.98	--	--	--	--	24.36	--	--	--
NERT Outfall	--	1.81	--	--	--	--	2.00	--	--	--	--	2.02	--	--	--	--	2.41	--	--	--	--	2.70	--	--	--
AMPAC/Endeavour Outfall	--	1.41	--	--	--	--	1.46	--	--	--	--	1.55	--	--	--	--	1.61	--	--	--	--	1.65	--	--	--
TIMET Outfall	--	5.95	--	--	--	--	5.54	--	--	--	--	5.86	--	--	--	--	4.55	--	--	--	--	4.97	--	--	--
Groundwater Inflow Rate (cfs) [a]	1.04	2.17	0.04	2.57	2.88	0.79	1.02	0.06	2.93	3.13	1.08	1.07	0.06	2.93	3.35	0.54	1.21	0.09	3.09	2.93	0.22	0.50	0.12	3.30	2.15
Evaporation from Wash (cfs) [b]	0.37	0.24	0.10	0.23	0.14	0.37	0.24	0.10	0.23	0.14	0.37	0.24	0.10	0.23	0.14	0.37	0.24	0.10	0.23	0.14	0.37	0.24	0.10	0.23	0.14
Conceptual Net Surface Water Flow Rate (cfs)	**263.0**	**293.8**	**293.8**	**296.1**	**298.9**	**265.1**	**296.3**	**296.3**	**299.0**	**302.0**	**265.4**	**296.8**	**296.8**	**299.5**	**302.7**	**258.6**	**290.2**	**290.2**	**293.0**	**295.8**	**265.1**	**299.0**	**299.1**	**302.1**	**304.1**
Measured Streamflow (cfs)	**NA**	**293.3**	**NA**	**NA**	**291.1**	**NA**	**293.2**	**NA**	**NA**	**304.5**	**255.6**	**302.2**	**293.5**	**300.6**	**304.9**	**273.7**	**324.0**	**289.2**	**311.2**	**293.8**	**263.4**	**314.1**	**291.0**	**310.5**	**298.3**
Percent Difference Between Conceptual and Measured Net Surface Water Flow Rate	**NA**	**0%**	**NA**	**NA**	**-3%**	**NA**	**-1%**	**NA**	**NA**	**1%**	**-4%**	**2%**	**-1%**	**0%**	**1%**	**5%**	**10%**	**0%**	**6%**	**-1%**	**-1%**	**5%**	**-3%**	**3%**	**-2%**

Notes:

cfs = cubic feet per second

-- = Not Applicable

NA= Not Available (Duck Creek Confluence, Bostic, and Homestead gage stations were installed in September 2016. Las Vegas Wasteway gage station has no data in 2016.)

AMPAC = American Pacific Corporation (now Endeavour, LLC)

COH = City of Henderson

NERT = Nevada Environmental Response Trust

TIMET = Titanium Metals Corporation

[a] From Table 2a

[b] Annual evaporation rates calculated from stream area within each reach and average evaporation rate reported in Moreo, M.T. and A. Swancar. 2013. Evaporation from Lake Mead, Nevada and Arizona, March 2010 through February 2012: U.S. Geological Survey Scientific Investigations Report 2013–5229, 40 p., http://dx.doi.org/10.3133/sir20135229) ISSN 2328-0328 (online).

TABLE 2c. GROUNDWATER EXTRACTION RATES
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well Name	Owner	Top of Screen		Bottom of Screen		2014 Pumping Rate (cfd)				2015 Pumping Rate (cfd)				2016 Pumping Rate (cfd)				2017 Pumping Rate (cfd)				2018 Pumping Rate (cfd)			
		Elevation (ft msl)	Model Layer	Elevation (ft msl)	Model Layer	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
ART-1	NERT [a]	1,602	1	1,562	2	4,488	4,484	4,517	3,576	1,594	1,496	1,380	0	0	0	0	2,540	6,417	6,901	8,091	7,946	7,681	7,485	7,340	7,355
ART-2	NERT	1,598	1	1,563	2	11,851	11,956	11,902	11,062	11,944	12,020	12,130	8,838	10,860	12,569	16,937	14,818	21,265	18,569	28,582	28,497	27,992	28,574	28,686	28,965
ART-3	NERT	1,603	1	1,573	1	9,064	8,963	8,741	8,615	8,396	8,443	8,401	8,620	10,480	10,605	6,734	5,336	6,275	5,562	3,670	3,418	3,709	3,633	3,720	3,745
ART-4	NERT	1,599	1	1,574	2	1,975	2,033	2,730	3,014	2,820	3,003	3,042	2,357	1,427	2,045	1,358	936	840	895	470	371	631	770	695	579
ART-7	NERT	1,599	1	1,579	1	5,949	5,978	5,950	5,909	5,843	5,604	5,106	4,945	3,081	3,758	2,694	3,038	3,884	3,737	3,231	3,123	3,137	3,166	3,300	3,525
ART-8	NERT	1,601	1	1,571	1	11,965	11,959	12,244	12,208	12,556	12,020	12,277	13,922	11,251	11,352	23,599	18,531	26,951	29,118	33,662	33,834	33,818	33,878	33,893	34,590
ART-9	NERT	1,584	1	1,576	2	8,521	8,968	9,242	9,712	10,838	11,728	11,415	12,404	11,237	11,682	12,853	11,760	11,307	10,181	9,987	11,659	12,605	11,847	11,591	11,923
I-AR	NERT	1,729	1	1,714	2	269	226	176	149	134	141	130	117	62	80	85	50	43	50	33	40	36	39	43	34
I-AA	NERT	1,727	1	1,707	2	--	58	164	253	186	188	236	216	126	171	120	113	195	159	188	195	218	213	184	192
I-AB	NERT	1,726	1	1,707	2	--	25	0	2	0	1	0	0	0	0	11	2	0	0	0	0	0	0	0	1
I-AC	NERT	1,726	1	1,706	2	--	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I-AD	NERT	1,727	1	1,708	2	--	25	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I-B	NERT	1,724	1	1,708	2	293	323	246	208	217	203	201	137	156	156	102	96	195	177	105	76	91	86	83	90
I-C	NERT	1,737	1	1,708	2	1,073	1,225	1,182	1,110	1,028	964	654	528	421	578	548	625	694	727	697	704	749	660	580	622
I-D	NERT	1,733	1	1,705	2	405	503	408	355	348	328	294	324	298	845	480	472	439	459	441	339	311	265	208	214
I-E	NERT	1,735	1	1,707	2	535	459	271	217	228	219	215	176	109	275	266	271	353	329	286	246	256	227	215	226
I-F	NERT	1,735	1	1,703	3	913	892	832	814	842	749	727	734	759	792	757	792	812	850	850	842	836	818	729	676
I-G	NERT	1,741	1	1,711	2	167	125	39	30	34	31	26	35	32	42	27	26	33	29	25	23	27	32	28	27
I-H	NERT	1,737	1	1,708	2	121	158	269	272	188	163	132	159	180	190	204	202	293	295	201	217	199	228	178	182
I-I	NERT	1,731	1	1,703	2	948	915	892	900	926	920	963	892	875	981	848	981	993	955	949	950	978	981	973	967
I-J	NERT	1,736	1	1,707	2	1,337	1,174	495	695	1,259	1,254	1,260	1,267	1,648	1,449	1,576	1,203	1,271	1,274	1,249	1,247	1,286	1,279	1,193	1,165
I-K	NERT	1,737	1	1,709	2	786	806	953	986	809	759	740	567	459	682	438	688	690	666	622	588	581	610	658	660
I-L	NERT	1,725	1	1,710	2	224	390	484	453	569	623	494	321	254	338	300	397	361	332	282	254	279	241	223	190
I-M	NERT	1,740	1	1,711	2	403	507	561	473	453	454	451	361	384	405	214	249	270	343	335	356	318	374	344	382
I-N	NERT	1,741	1	1,711	2	422	469	595	475	365	534	488	418	511	799	743	721	819	770	807	744	690	569	423	465
I-O	NERT	1,741	1	1,711	2	166	425	490	524	312	277	226	173	124	170	140	68	42	48	143	166	172	129	159	257
I-P	NERT	1,733	1	1,705	2	1,100	701	716	703	410	349	299	435	367	457	421	452	395	363	310	350	349	397	341	350
I-Q	NERT	1,740	1	1,712	2	180	173	104	90	85	80	77	95	103	126	120	95	138	134	37	31	43	42	46	77
I-R	NERT	1,724	1	1,708	2	752	696	529	476	461	455	473	406	336	396	210	230	188	236	277	281	267	217	169	217
I-S	NERT	1,734	1	1,705	2	823	764	964	986	928	885	982	780	721	902	797	702	1,029	902	728	556	489	394	346	361
I-T	NERT	1,736	1	1,707	2	110	67	89	89	72	75	77	51	70	90	85	90	95	103	93	81	63	85	89	86
I-U	NERT	1,737	1	1,708	2	214	181	163	175	182	183	177	167	105	139	149	148	172	141	142	142	147	150	140	140
I-V	NERT	1,737	1	1,708	2	1,119	1,121	1,085	1,059	949	832	840	830	751	820	754	802	813	840	833	833	834	831	817	817
I-W	NERT	1,728	1	1,699	3	--	73	192	201	157	85	113	95	162	173	206	156	135	164	148	131	72	152	123	113
I-X	NERT	1,725	1	1,697	3	--	420	690	616	633	396	367	414	207	388	353	315	369	404	689	621	767	696	642	616
I-Y	NERT	1,724	1	1,699	3	--	110	267	270	299	285	247	214	113	148	226	247	244	276	259	240	267	258	247	252
I-Z	NERT	1,726	1	1,706	2	1,537	1,267	581	741	1,396	1,262	1,256	1,292	1,348	1,429	1,240	1,434	1,471	1,475	1,458	1,488	1,539	1,472	1,365	1,370
PC-115R	NERT	1,544	1	1,505	1	18,522	16,249	18,264	18,385	19,385	17,892	17,971	15,482	21,070	21,000	19,392	17,331	21,096	21,481	24,737	24,925	24,951	25,004	24,906	25,069
PC-116R	NERT	1,542	1	1,502	1	23,698	23,562	23,973	24,035	27,504	27,557	29,237	25,855	24,897	24,894	29,182	25,554	27,446	25,482	32,157	32,323	32,061	32,172	32,014	32,153
PC-117	NERT	1,541	1	1,502	1	17,799	17,700	17,859	18,038	21,526	19,455	18,277	16,139	21,120	22,549	22,840	18,044	21,500	21,692	20,550	22,266	22,236	22,281	21,961	22,220
PC-118	NERT	1,547	1	1,507	1	12,124	11,916	14,524	15,007	14,835	14,840	15,226	13,537	11,231	12,081	12,944	10,034	11,228	11,586	14,966	11,990	11,488	11,415	11,214	11,778
PC-119	NERT	1,540	1	1,510	1	11,867	11,801	12,025	12,022	10,213	11,111	12,179	11,340	11,232	10,386	7,899	9,133	11,270	12,481	16,966	20,351	19,456	19,492	19,389	19,409
PC-120	NERT	1,540	1	1,509	1	0	1	3	1	13	1	0	0	0	0	0	67	9,334	16,885	16,292	11,883	9,766	9,909	9,737	9,750
PC-121	NERT	1,548	1	1,518	1	0	1	0	1	12	1	0	0	4	1	0	297	3,859	7,309	6,516	4,653	3,808	3,720	3,705	3,731
PC-133	NERT	1,549	1	1,514	1	812	809	812	803	810	820	1,616	1,383	1,939	1,472	1,156	1,205	1,804	1,832	1,810	1,897	1,941	1,908	1,901	1,926
PC-150	NERT	1,599	1	1,579	1	--	--	--	472	866	866	778	735	670	637	477	392	241	154	283	290	289	289	289	289
PC-99R2/R3	NERT	1,541	1	1,503	1	11,845	12,000	11,986	12,012	15,160	12,173	12,177	13,295	11,308	12,168	13,328	10,737	13,045	12,270	16,164	16,698	17,321	17,157	16,412	16,647
A	OSSM [b]	1,691	1	1,681	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B	OSSM	1,683	1	1,668	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C	OSSM	1,687	1	1,677	1	2,695	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
D2	OSSM	1,681	1	1,677	2	1,348	1,412	1,155	1,412	1,540	1,412	1,348	1,283	1,155	1,219	1,283	1,283	1,283	1,412	1,540	1,604	1,348	1,540	1,540	1,733

TABLE 2c. GROUNDWATER EXTRACTION RATES
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well Name	Owner	Top of Screen		Bottom of Screen		2014 Pumping Rate (cfd)				2015 Pumping Rate (cfd)				2016 Pumping Rate (cfd)				2017 Pumping Rate (cfd)				2018 Pumping Rate (cfd)			
		Elevation (ft msl)	Model Layer	Elevation (ft msl)	Model Layer	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
D3	OSSM	1,691	1	1,676	2	--	--	--	--	0	257	578	578	513	385	385	385	449	257	321	193	321	193	193	193
E3	OSSM	1,689	1	1,679	1	4,235	4,556	4,748	5,069	5,262	5,326	5,262	5,518	5,069	4,813	4,813	5,262	5,005	4,941	5,005	4,877	3,593	4,171	3,914	5,708
F	OSSM	1,694	1	1,674	2	1,733	2,246	1,989	1,925	1,861	1,733	1,733	1,733	1,733	1,476	1,412	1,668	1,861	1,925	1,925	1,861	1,733	1,668	1,540	1,540
G	OSSM	1,692	1	1,672	2	1,348	1,989	1,733	1,668	1,797	1,733	1,797	1,733	1,733	1,540	1,540	1,733	1,797	1,861	1,925	1,989	1,925	2,053	1,668	2,118
H2	OSSM	1,683	1	1,673	1	2,118	2,182	2,182	2,118	2,118	2,118	2,118	2,118	2,118	2,118	2,310	2,438	2,182	1,925	2,823	2,695	2,759	2,631	2,695	2,695
I	OSSM	1,693	1	1,683	1	1,348	1,348	1,155	1,155	1,283	1,412	1,348	1,155	1,155	1,219	1,348	1,348	1,283	1,348	1,604	1,668	1,604	1,540	1,668	1,670
J	OSSM	1,684	1	1,679	2	1,668	1,540	1,283	1,155	1,155	1,091	963	963	1,091	1,027	1,091	1,155	1,155	1,155	1,219	1,283	963	963	770	963
J2	OSSM	1,691	1	1,676	2	--	--	--	--	0	128	193	193	193	193	193	193	257	385	385	385	385	385	385	385
K2	OSSM	1,698	1	1,679	1	2,503	1,797	1,668	1,861	1,989	1,925	1,861	1,733	1,797	1,604	1,733	1,797	1,861	1,925	2,118	2,118	1,989	2,438	2,759	2,825
L	OSSM	1,680	2	1,675	2	1,668	2,053	1,733	1,348	1,348	1,219	1,476	1,797	1,733	1,540	1,283	1,155	1,348	1,540	1,155	1,733	2,118	2,310	2,310	2,310
M	OSSM	1,681	2	1,677	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
M2	OSSM	1,700	1	1,680	2	1,540	1,283	1,027	1,027	1,027	1,155	834	963	963	898	963	963	963	642	1,155	1,155	1,219	1,155	1,091	1,155
N	OSSM	1,697	1	1,682	1	193	193	193	193	193	193	193	321	321	193	193	257	257	193	193	193	193	193	193	193
O	OSSM	1,688	1	1,668	2	2,503	2,503	2,503	2,438	2,310	2,310	2,182	2,118	1,989	2,118	2,503	2,631	2,118	2,438	2,503	2,503	2,503	2,695	2,631	2,695
P	OSSM	1,698	1	1,678	1	2,246	2,503	2,567	2,759	2,888	2,695	2,503	2,567	2,503	1,861	2,118	2,118	1,861	1,476	1,540	2,053	2,438	2,246	2,182	2,438
Q	OSSM	1,683	1	1,674	2	1,604	1,797	2,118	2,118	1,925	1,925	1,989	1,925	1,925	1,540	1,668	1,604	1,155	1,925	1,925	1,925	1,733	1,733	1,604	1,733
R	OSSM	1,683	1	1,676	2	770	834	770	770	770	770	770	770	834	706	642	642	706	578	834	963	963	963	898	963
AMEW-1	AMPAC [c]	1,686	4	1,596	5	24,069	34,002	35,305	34,008	35,343	44,115	45,321	37,473	48,305	49,825	50,377	39,751	46,251	53,015	53,175	53,310	53,265	53,188	46,418	52,531
AMEW-2	AMPAC	1,627	5	1,587	5	5,692	10,709	9,702	10,504	10,312	11,627	6,141	9,670	11,698	11,659	11,852	8,502	9,266	11,929	12,686	12,346	12,320	12,423	10,716	10,387
AMEW-3	AMPAC	1,614	5	1,584	5	10,312	9,933	9,882	9,843	10,061	9,920	9,529	9,118	9,426	9,824	10,254	9,901	5,230	9,631	9,651	9,651	9,638	9,599	9,246	8,845
AMEW-4	AMPAC	1,658	4	1,623	5	8,630	7,995	7,642	7,020	7,745	7,944	7,803	6,847	8,586	8,143	7,989	7,200	8,059	7,578	6,776	6,276	6,192	5,634	5,935	5,408
AMEW-5	AMPAC	1,620	5	1,585	5	2,490	6,821	6,673	6,301	9,073	9,163	8,855	6,930	8,470	9,477	8,752	7,771	8,996	7,963	9,189	9,330	9,972	9,959	8,945	8,804
APEW-1	AMPAC	1,604	1	1,584	2	0	0	0	0	0	1,020	2,753	2,612	3,022	3,054	2,811	2,990	3,022	3,022	3,343	3,536	3,542	3,138	3,985	4,184
APEW-2	AMPAC	1,601	1	1,591	1	5,756	9,554	8,592	5,281	4,274	4,132	3,966	4,113	5,319	5,352	5,544	5,570	5,627	5,583	4,986	5,018	5,024	5,050	5,409	5,685
APEW-3	AMPAC	1,596	1	1,585	3	1,360	1,328	1,380	1,380	1,367	1,367	1,380	1,309	1,405	1,418	1,437	1,450	1,463	1,457	1,450	1,444	1,476	1,418	1,283	1,277
AREW-1	AMPAC	1,624	1	1,614	1	5,275	5,826	4,890	5,056	5,698	4,626	3,651	3,388	2,920	2,547	2,355	2,689	2,316	2,310	2,291	2,291	2,291	2,214	1,899	2,041
AREW-2	AMPAC	1,619	1	1,604	2	10,434	10,241	10,164	8,797	9,882	9,176	7,841	7,347	6,936	5,942	6,442	7,078	7,174	7,552	7,052	6,930	6,365	5,730	5,506	5,756
AREW-3	AMPAC	1,618	1	1,608	1	4,659	4,607	4,639	4,633	4,633	3,433	4,652	4,684	4,620	4,607	4,614	4,639	4,703	4,678	4,665	4,678	4,697	4,671	4,498	4,652
AREW-4	AMPAC	1,617	1	1,607	1	4,691	3,978	3,208	3,035	2,663	2,060	1,502	1,495	1,527	1,405	2,015	2,932	3,247	3,125	3,221	3,856	4,023	3,773	3,427	3,732
AREW-5	AMPAC	1,611	1	1,596	2	20,084	20,084	20,341	20,790	20,020	19,635	19,443	19,507	19,250	19,186	19,378	17,967	19,828	19,828	19,763	19,828	19,828	19,828	17,453	16,777
AREW-6	AMPAC	1,614	1	1,599	2	4,479	4,633	4,505	4,601	4,588	4,556	4,511	4,248	4,453	4,453	4,498	4,460	4,485	4,331	4,665	4,601	4,575	4,588	4,415	4,562
EWQal-01	TIMET [d]	1,720	1	1,701	2	0	0	0	0	0	0	0	0	0	183	355	337	347	305	264	201	105	117	121	59
EWQal-02	TIMET	1,725	1	1,709	1	0	0	0	0	0	0	0	0	0	164	323	313	168	271	328	354	404	438	449	300
EWQal-03	TIMET	1,725	1	1,709	1	218	317	270	373	400	352	397	381	363	356	209	319	515	451	528	423	474	387	271	212
EWQal-04	TIMET	1,727	1	1,711	1	116	101	113	146	96	150	265	241	223	222	244	255	233	209	321	356	323	255	312	359
EWQal-05	TIMET	1,729	1	1,713	1	780	765	832	813	1,122	929	995	563	904	885	828	633	887	885	1,021	956	937	923	912	882
EWQal-06	TIMET	1,728	1	1,710	2	268	286	286	340	310	474	509	620	479	464	455	491	504	503	473	483	505	500	517	514
EWQal-07	TIMET	1,717	1	1,706	2	229	189	191	264	314	244	325	291	283	295	320	337	390	381	405	342	355	344	355	203
EWQal-08	TIMET	1,723	1	1,698	3	460	486	468	426	646	502	391	543	491	537	465	632	644	1,910	570	482	547	494	496	315
EWQal-09	TIMET	1,722	1	1,702	3	549	647	758	997	856	975	881	925	791	456	880	965	1,105	783	1,162	877	744	769	807	551
EWQal-10	TIMET	1,728	1	1,708	2	597	832	1,068	1,245	1,237	1,256	1,077	1,283	1,002	1,009	965	1,077	1,192	1,137	1,366	1,308	1,290	1,265	1,236	1,229
EWQal-11	TIMET	1,732	1	1,712	2	256	385	454	414	415	353	380	297	463	411	463	391	488	495	555	502	427	393	351	304
EWQal-12	TIMET	1,732	1	1,712	2	225	177	203	171	155	150	160	280	212	218	197	196	225	193	279	216	250	229	209	223
EWQal-13	TIMET	1,734	1	1,715	2	187	214	268	255	197	201	276	330	253	303	275	306	322	287	363	400	420	334	396	426
EWQal-14	TIMET	1,733	1	1,708	3	129	93	101	117	123	107	121	121	87	105	90	112	100	109	146	381	121	193	180	739
EWQal-15	TIMET	1,740	1	1,705	3	291	239	234	170	262	132	207	538	269	262	269	322	293	226	285	284	272	267	358	280
EWQal-16	TIMET	1,741	1	1,721	2	0	180	170	157	169	198	209	368	211	226	148	235	272	244	211	242	230	230	225	230
EWQal-17	TIMET	1,745	1	1,728	1	0	0	0	0	0	0	0	0	60	64	70	128	195	181	124	214	234	97	64	232
EWQal-18	TIMET	1,747	1	1,723	2	0	0	0	0	0	0	0	0	0	0	61	190	266	187	140	--	--	--	--	--
EWQal-19	TIMET	1,747	1	1,723	3	0	0	0	0	0	0	0	0	0	0	117	190	227	195	125	--	--	--	--	--

TABLE 2c. GROUNDWATER EXTRACTION RATES
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well Name	Owner	Top of Screen		Bottom of Screen		2014 Pumping Rate (cfd)				2015 Pumping Rate (cfd)				2016 Pumping Rate (cfd)				2017 Pumping Rate (cfd)				2018 Pumping Rate (cfd)			
		Elevation (ft msl)	Model Layer	Elevation (ft msl)	Model Layer	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
E1-1	NERT	1,733	1	1,708	3	--	--	--	--	--	--	--	--	--	--	--	122	595	651	321	287	367	476	442	413
E1-2	NERT	1,733	1	1,708	3	--	--	--	--	--	--	--	--	--	--	--	61	188	233	256	250	238	209	208	156
E1-3	NERT	1,733	1	1,708	3	--	--	--	--	--	--	--	--	--	--	--	43	177	184	169	163	160	117	95	117
E2-1	NERT	1,732	1	1,707	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	178	276	221	180	157	155
E2-2	NERT	1,730	1	1,705	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	227	362	305	236	233	221
E2-3	NERT	1,731	1	1,706	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	250	382	310	231	215	208
E2-4	NERT	1,734	1	1,709	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	172	391	333	263	229	240
E2-5	NERT	1,730	1	1,705	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	95	144	146	108	63	68
Sunrise Mountain Weir Trench [e]	SNWA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	300,601	402,490	174,088	0
Historic Lateral Weir Trench [e]	SNWA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	217,906	197,506	0	0

Notes:
cfd = cubic feet per day
ft msl = feet above mean sea level
-- = Not available
AMPAC = American Pacific Corporation (now Endeavour, LLC)
NERT = Nevada Environmental Response Trust
OSSM = Olin Chlor-Alkali/Stauffer/Syngenta/Montrose
SNWA = Southern Nevada Water Authority
TIMET = Titanium Metals Corporation
[a] NERT data obtained from GWETS Field Sheets.
[b] OSSM data are obtained from OSSM monitoring and operations reports.
[c] AMPAC data are compiled from AMPAC monitoring reports.
[d] TIMET data are compiled from TIMET monitoring reports.
[e.] Weir dewatering data are compiled from dewatering water treatment operation and maintenance summaries.

TABLE 2d. CONCEPTUAL GROUNDWATER BALANCE SUMMARY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

	Flow Component	Steady-State (2014)	2014				2015				2016				2017				2018			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Groundwater Inflow	Southern Boundary inflow [a,b]	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
	Northern Boundary infow [a,b]	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000
	Western Boundary Inflow Beneath the Wash [a,b]	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000
	Adjacent Basin Inflow [a,c]	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000	190,000
	Areal Recharge (Total)	156,136	156,128	155,301	176,407	136,707	139,820	173,554	179,607	182,753	158,685	262,632	184,563	256,004	253,390	189,739	243,099	222,026	246,265	268,576	285,707	282,551
	Infiltration from Bird Viewing Pond	77,591	77,989	76,948	102,702	52,726	66,726	99,874	104,991	66,257	73,705	167,004	109,053	132,414	129,507	110,967	165,744	120,589	154,895	186,369	208,423	180,300
	Infiltration from Pond 13 [d]	7,001	6,596	6,809	2,162	12,437	573	1,160	2,095	43,975	12,390	23,037	2,920	51,000	49,300	4,187	2,771	26,853	15,972	6,809	1,886	26,853
	Infiltration from Industrial Area [e]	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,504	29,504	29,504	29,504
	Infiltration from Residential Area [e]	32,076	32,076	32,076	32,076	32,076	33,053	33,053	33,053	33,053	33,123	33,123	33,123	33,123	35,116	35,116	35,116	35,116	35,895	35,895	35,895	35,895
	Golf Course Recharge [f]	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
	Infiltration from Undeveloped Area [g]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Focused Recharge (Total)	68,532	78,145	67,967	64,897	63,117	70,024	72,565	74,634	75,690	72,631	72,630	76,535	82,696	83,063	87,966	88,624	88,749	80,571	82,458	86,832	83,936
	NERT Stormwater Retention Basins [h]	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837
	NERT Recharge Trenches [i]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pioneer Detention Basin [h]	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788
	Tuscany Golf Course/Weston Hill Subdrains [j]	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600
	Athens Main Drainage Channel [k]	22,281	31,102	21,599	19,433	16,991	23,036	25,920	28,076	28,221	26,494	28,798	31,102	35,414	35,927	39,867	38,564	38,308	31,923	33,123	38,308	32,340
	TIMET Injection [l]	5,130	4,302	4,911	5,418	5,888	6,300	6,021	6,191	6,782	6,091	6,160	6,735	7,429	8,374	8,952	8,666	8,021	7,639	7,235	7,259	7,060
	OSSM Injection [l]	27,896	29,517	28,233	26,822	27,014	27,463	27,399	27,143	27,463	26,822	24,448	25,474	26,629	25,538	25,923	28,169	29,196	27,784	28,875	28,041	31,313
	Total Inflow (cfd)	**1,320,000**	**1,330,000**	**1,320,000**	**1,340,000**	**1,300,000**	**1,310,000**	**1,340,000**	**1,350,000**	**1,360,000**	**1,330,000**	**1,430,000**	**1,360,000**	**1,440,000**	**1,430,000**	**1,380,000**	**1,430,000**	**1,410,000**	**1,420,000**	**1,450,000**	**1,470,000**	**1,460,000**
Groundwater Outflow	Groundwater Extraction (Total)	320,000	306,124	325,520	327,370	322,352	337,205	337,922	334,037	313,042	331,337	337,719	353,338	318,565	374,853	396,576	431,741	430,431	684,718	723,280	494,419	418,996
	NERT (IWF) [m]	13,735	13,895	14,281	13,435	13,326	13,470	12,697	12,146	11,205	10,681	13,020	11,418	11,628	12,551	12,499	12,187	11,745	11,865	11,443	10,546	10,749
	NERT (AWF) [m]	54,395	53,814	54,341	55,327	54,098	53,991	54,313	53,751	51,087	48,336	52,011	64,175	56,959	76,939	74,963	87,694	88,848	89,572	89,352	89,225	90,682
	NERT (SWF) [m]	97,733	96,668	94,041	99,446	100,776	110,322	104,718	107,461	97,765	103,471	105,188	107,219	92,795	120,822	131,171	150,443	147,276	143,317	143,347	141,528	142,972
	NERT (AP Area Wells) [m]	0	-	-	-	-	-	-	-	-	-	-	-	226	960	1,068	1,669	2,254	2,080	1,818	1,641	1,579
	OSSM [m]	27,896	29,517	28,233	26,822	27,014	27,463	27,399	27,143	27,463	26,822	24,448	25,474	26,629	25,538	25,923	28,169	29,196	27,784	28,875	28,041	31,313
	AMPAC/Endeavour [m]	121,453	107,929	129,713	126,922	121,249	125,658	132,774	127,345	118,740	135,937	136,893	138,318	122,898	129,668	142,001	142,912	143,092	143,207	141,212	129,135	134,641
	TIMET [m]	5,130	4,302	4,911	5,418	5,888	6,300	6,021	6,191	6,782	6,091	6,160	6,735	7,429	8,374	8,952	8,666	8,021	7,639	7,235	7,259	7,060
	Weir Dewatering (Sunrise Mountain) [n]	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	150,301	201,245	87,044	0
	Weir Dewatering (Historic Lateral) [n]	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	108,953	98,753	0	0
	Groundwater Discharge to the Wash [o]	720,000	720,000	720,000	720,000	720,000	660,000	660,000	660,000	660,000	700,000	700,000	700,000	700,000	660,000	660,000	660,000	660,000	530,000	530,000	530,000	530,000
	Eastgate Storm Drain [k]	16,000	22,452	14,681	14,688	13,533	13,822	12,378	13,533	15,843	15,836	15,554	16,420	16,132	17,774	16,805	18,993	18,993	21,509	18,859	20,469	20,148
	Athens Drainage Channel [k]	5,900	8,650	6,918	4,745	3,458	9,214	13,542	14,543	12,378	10,658	13,244	14,682	19,282	18,153	23,062	19,571	19,315	10,414	14,264	17,839	12,192
	Tuscany Golf Course/Weston Hill Subdrains [p]	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600
	Eastern Boundary Outflow Beneath the Wash [q]	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
	Evapotranspiration from Phreatophytes [r]	213,826	30,345	364,138	333,793	151,724	22,069	264,828	242,759	110,345	24,828	297,931	273,103	124,138	22,069	264,828	242,759	110,345	22,069	264,828	242,759	110,345
	Evaporation from Gravel Pit [s]	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
	Total Outflow (cfd)	**1,320,000**	**1,130,000**	**1,480,000**	**1,450,000**	**1,260,000**	**1,090,000**	**1,340,000**	**1,310,000**	**1,160,000**	**1,130,000**	**1,410,000**	**1,400,000**	**1,220,000**	**1,140,000**	**1,410,000**	**1,420,000**	**1,290,000**	**1,320,000**	**1,600,000**	**1,350,000**	**1,140,000**
Change in Storage, Inflow minus Outflow (cfd)		**--**	**200,000**	**-160,000**	**-110,000**	**40,000**	**220,000**	**0**	**40,000**	**200,000**	**200,000**	**20,000**	**-40,000**	**220,000**	**290,000**	**-30,000**	**10,000**	**120,000**	**100,000**	**-150,000**	**120,000**	**320,000**

Notes:

cfd = cubic feet per day
-- = Not Applicable
AWF = Athens Road Well Field
IWF = Interceptor Well Field
SWF = Seep Well Field
AMPAC = American Pacific Corporation (now Endeavour, LLC)
NERT = Nevada Environmental Response Trust
OSSM = Olin Chlor-Alkali/Stauffer/Syngenta/Montrose
TIMET = Titanium Metals Corporation
The total inflow and outflow values have been rounded to three significant figures, after calculations.

[a] Boundary inflows are expected to be constant during the model simulation period.
[b] Estimated based on watershed area and precipitation recharge (Table 2e).
[c] Based on USGS (2004).
[d] Estimated as inflow rate plus precipitation rate minus evaporation rate.
[e] Based on estimate of leakage from water mains.
[f] Based on water usage and percent estimate to prevent salt buildup in the root zone.
[g] Negligible recharge expected in undeveloped areas based on the resources below:

Sanford, W. E. and D.L.Selnick. 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* 49(1).

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.

[h] Based on rainfall and recharge percentage for retention basins, from the resource below:

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.

[i] NERT Field Spreadsheet.
[j] RI Phase 3, Modification #2.
[k] AMPAC/Endeavor Monitoring Reports.
[l] Equal to quarterly average pumping.
[m] See Table 2c.
[n] Applied as 50% of total weir dewatering (see Table 2c).
[o] Estimated net discharge (See Table 1).
[p] Field Estimation.
[q] Based on USGS (1996) with adjustment to balance inflows and outflows.
[r] Estimated based on area of phreatophytic vegetation and evapotranspiration rate.
[s] Estimated based on area of standing water in the gravel pit and evaporation rate.

TABLE 2e. EVALUATION OF UNCERTAINTY IN CONCEPTUAL BOUNDARY INFLOWS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Zone	Epstein, et al. (2010) in cfd			Donovan and Katzer (2000) Method in cfd		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Southern Boundary Inflow	132,814	0	634,180	56,151	17,874	230,320
Western Boundary Inflow, Beneath the Wash	456,196	211,468	747,555	467,890	30,749	5,299,981
Northern Boundary Infow	7,619	0	16,113	1,645	1,518	2,019
Total Boundary Inflows	600,000	210,000	1,400,000	530,000	50,000	5,500,000

Notes:

cfd = cubic feet per day

Donovan, D.J. and T. Katzer. 2000. Hydrogeologic Implications of Greater Ground-Water Recharge to Las Vegas Valley, Nevada. *Journal of the American Water Resources Association* 36(5): 1133-1148.

Epstein, B. J., G.M. Pohll, J. Huntington and R.W.H. Carroll. 2010. Development and Uncertainty Analysis of an Empirical Recharge Prediction Model for Nevada's Desert Basins. *Journal of the Nevada Water Resources Association*. Summer 2010.

Total boundary inflows were rounded to two significant figures, after calculations.

TABLE 3. MODEL LAYERS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust
Henderson, Nevada

Model Layer	Lithology [see notes]	Layer Thickness (ft)
1	Alluvium	4 - 188
2	xMCf, UMCf-fg, UMCf-cg (W, C, E)	4 - 137
3	UMCf-fg, UMCf-cg (W, E)	4 - 74
4	UMCf-fg, UMCf-cg (W, E)	11 - 67
5	UMCf-fg, UMCf-cg (W, E)	11 - 67
6	UMCf-fg, UMCf-cg (W, E)	17 - 83
7	UMCf-fg, UMCf-cg (W, E)	17 - 83
8	UMCf-fg, UMCf-cg (W, E)	10 - 109
9	UMCf-fg, UMCf-cg (W, C, E)	10 - 109
10	UMCf-fg, UMCf-cg (C, E)	65 - 281

Notes:

ft = feet

UMCf-fg = Fine-grained Upper Muddy Creek Formation

UMCf-cg = Coarse-grained Upper Muddy Creek Formation

xMCf = Transitional Muddy Creek Formation

W, C and E regions of the UMCf-cg correspond to model areas underlying the southwest (AMPAC/Endeavour area), south central (upgradient NERT area), and southeast (BMI upper pond area) portions of the model domain, respectively.

TABLE 4. ESTIMATED VERSUS CALIBRATED HYDRAULIC CONDUCTIVITY AND STORAGE PROPERTIES
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Lithologic Unit	Average Horizontal Hydraulic Conductivity (ft/day) [a]						Vertical Hydraulic Conductivity (ft/day) [b]					Specific Yield [c]	Specific Storage (1/ft) [d]	
	Method	Well Count	Geometric Mean	Minimum	Maximum	Calibrated	Well Count	Geometric Mean	Minimum	Maximum	Calibrated	Calibrated	Estimated	Calibrated
Qal	Specific Capacity	12	28	7.7	108	45	29	0.2	2.5E-04	4.3	0.40	0.10	0.03	4.5E-05
	Lab	2	0.01	0.01	0.01									
	Pump	25	25	1.2	777									
	Slug	88	16	0.1	307									
Qal/UMCf	Specific Capacity	--	--	--	--	--	1	3.0E-03	3.0E-03	3.0E-03	--	--	2.2E-03	--
	Lab	11	0.03	5.4E-04	1.4									
	Pump	8	2.6	0.03	300									
	Slug	27	3.0	0.2	53									
Qal/xMCf	Specific Capacity	--	--	--	--	--	--	--	--	--	--	--	--	--
	Lab	--	--	--	--									
	Pump	1	2.4	2.4	2.4									
	Slug	1	2.8	2.8	2.8									
xMCf	Specific Capacity	--	--	--	--	6	3	3.2E-04	1.7E-04	5.9E-04	0.60	0.20	5.7E-02	6.5E-05
	Lab	--	--	--	--									
	Pump	13	0.1	1.2E-03	5.4									
	Slug	3	3.0	0.1	60									
xMCf/UMCf	Specific Capacity	--	--	--	--	--	--	--	--	--	--	--	6.6E-04	--
	Lab	--	--	--	--									
	Pump	1	0.7	0.7	0.7									
	Slug	4	4.6	2.0	8.1									
UMCf-cg	Specific Capacity	--	--	--	--	1-30	--	--	--	--	0.1-3	0.24	3.6E-04	4.0E-05
	Lab	--	--	--	--									
	Pump	9	0.1	1.3E-05	5.6									
	Slug	16	2.4	0.2	265									
UMCf	Specific Capacity	8	0.6	0.2	3.0	0.72	35	2.7E-03	6.1E-07	0.2	0.07	0.21	1.4E-03	7.5E-05
	Lab	15	2.0E-03	6.0E-05	0.8									
	Pump	23	0.1	4.4E-07	6.6									
	Slug	276	0.2	6.8E-04	11									
UMCf / Horse Springs	Specific Capacity	--	--	--	--	0.66	--	--	--	--	1	0.24	--	--
	Lab	--	--	--	--									
	Pump	--	--	--	--									
	Slug	3	2.0	0.4	10									

TABLE 4. ESTIMATED VERSUS CALIBRATED HYDRAULIC CONDUCTIVITY AND STORAGE PROPERTIES
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Lithologic Unit	Average Horizontal Hydraulic Conductivity (ft/day) [a]						Vertical Hydraulic Conductivity (ft/day) [b]					Specific Yield [c]	Specific Storage (1/ft) [d]	
	Method	Well Count	Geometric Mean	Minimum	Maximum	Calibrated	Well Count	Geometric Mean	Minimum	Maximum	Calibrated	Calibrated	Estimated	Calibrated
Wash Gravels	Specific Capacity	--	--	--	--	100-700	--	--	--	--	10-70	0.10	0.12	5.0E-05
	Lab	17	0.1	2.8E-04	12									
	Pump	7	1099	629	1959									
	Slug	45	15	7.9E-04	420									
Paleochannels	Specific Capacity	--	--	--	--	175-550	--	--	--	--	17.5 - 55		--	
	Lab	1	0.02	0.02	0.02								--	
	Pump	38	95	4.5	1185								0.02	
	Slug	17	20	0.04	200								0.05	

Notes:
ft = feet
ft/day = feet per day
-- = Not Applicable
Qal = Quaternary Alluvium
UMCf = Upper Muddy Creek Formation
UMCf-cg = UMCf, coarse-grained
xMCf = Transitional Muddy Creek Formation
a Statistics derived from compiled historic and recent aquifer testing results (see Appendix D).
b Statistics derived from the vertical conductivity data in Appendix E4 of the Phase 5 Model (Ramboll Environ 2016), see Appendix D.
c Values for specific yield are assumed to be equal to the mobile porosity.
d Statistics derived from the storage parameter information in Appendix E5 of the Phase 5 Model (Ramboll Environ 2016), updated in Appendix D.

TABLE 5. WEIR SPECIFICATIONS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Weir Name	Year Completed	Channel EL at Approach	Approach Distance	Crest EL	Crest Distance	Chute Distance	Chute Slope	Apron EL	Apron Distance	Total Weir Distance (approach to end of apron)	Weir Drop	Weir Length	Upstream Wash Width	Weir Separation Distance (edge of upstream apron to approach)	Weir BSP	Apron BSP	Weir Contact EL[a]	Apron Contact EL[a]	Simulated SP at Weir	Simulated SP at Apron
Unit	*yr*	*ft*	*ft*	*ft*	*ft*	*ft*	*ft/ft*	*ft*	*ft*	*ft*	*ft*	*ft*	*ft*	*ft*	*ft msl*	*ft msl*	*ft msl*	*ft msl*	*Model Layer*	*Model Layer*
DU Wetlands No. 2	2009	1,598	24	1,599	20	140	0.050	1,592	70	254	7	285	280	865	1,577	1,569	1,574	1,574	1	1,2
DU Wetlands No. 1	2013	1,589	20	1,590	24	260	0.050	1,577	90	394	13	284	200	940	1,567	1,554	1,564	1,567	1	1,2
Silver Bowl	2015	1,576	24	1,577	24	160	0.050	1,569	50	258	8	450	330	730	1,552	1,544	1,560	1,554	1,2	1,2
Archery	2015	1,568	24	1,569	24	160	0.050	1,561	50	258	8	450	360	1,050	1,544	1,536	1,524	1,523	1	1
Duck Creek Confluence	2013	1,560	12	1,561	20	200	0.050	1,551	45	277	10	650	530	1,267	1,534	1,534	1,531	1,527	1	1
Upper Narrows	2013	1,550	12	1,551	20	220	0.050	1,540	45	297	11	650	500	879	1,520	1,520	1,519	1,522	1	1
Sunrise Mountain	2018	1,539	24	1,540	24	80	0.050	1,536	60	188	4	500	300	1,275	1516	--	--	--	NE	NE
Pabco Road	2000	1,535	6	1,536	15	15	0.350	1,531	48	84	5.25	690	400	1,400	1,513	--	1,518	--	1	--
Historic Lateral Expansion	2018	1,518	32	1,519	24	200	0.050	1,509	0	256	10	600	60	3,800	1,498	1,503	1,470	1,465	--	--
Bostic	2003	1,508	24	1,509	39	310	0.050	1,493	70	443	15.5	794	400	1,820	1,486	1,474	1,440	1,440	--	--
Calico Ridge	2005	1,490	18	1,491	43	120	0.050	1,485	60	241	6	396	200	1,050	1,473	1,467	1,444	1,445	1	1
Lower Narrows	2011	1,484	20	1,485	20	260	0.050	1,472	50	350	13	483	400	1,240	1,462	1,448	1,434	1,431	1	1
Homestead	2011	1,471	20	1,472	20	358	0.050	1,454	50	448	17.9	473	240	1,410	1,449	1,430	1,434	1,432	1	1
Three Kids	2015	1,452	39.5	1,453	24	408	0.042	1,436	50	522	17	450	330	1,602	1,424	1,407	1,424	1,418	1	1,2
Rainbow Gardens	2004	1430	8.5	1,435	17	87	0.103	1,426	150	263	9	164	80	1770	1,387	1,410	NE	NE	NE	NE

Notes:
ft = feet
ft/ft = feet per foot
ft msl = feet above mean sea level
yr = year
-- = Not Applicable
NE = Not Evaluated (outside of the model boundary)
BSP = Bottom of Sheet Pile
EL = Elevation
SP = Sheet Pile
[a] Contact elevation of Alluvium and Upper Muddy Creek Formation, as implemented in the model
Weir names are listed in order of upstream to downstream

TABLE 6. SIMULATED GROUNDWATER INFLOWS AND OUTFLOWS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

	Flow Component	Steady-State (2014)	2014				2015				2016				2017				2018			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Groundwater Inflow	Southern/Northern/Western Boundary Inflow	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823	841,823
	Areal Recharge (Total)	224,798	234,335	223,833	241,033	199,998	209,866	246,256	254,224	258,280	230,878	335,524	261,055	338,347	336,581	277,892	332,215	310,522	326,932	350,932	372,250	367,167
	Infiltration from Bird Viewing Preserve	77,591	77,989	76,948	102,702	52,726	66,726	99,874	104,991	66,257	73,705	167,004	109,053	132,414	129,507	110,967	165,744	120,589	154,895	186,369	208,423	180,300
	Infiltration from Pond 13	7,001	6,596	6,809	2,162	12,437	573	1,160	2,095	43,975	12,390	23,037	2,920	51,000	49,300	4,187	2,771	26,853	15,972	6,809	1,886	26,853
	Infiltration from Industrial Area	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,468	29,504	29,504	29,504	29,504
	Infiltration from Residential Area	32,076	32,076	32,076	32,076	32,076	33,053	33,053	33,053	33,053	33,123	33,123	33,123	33,123	35,116	35,116	35,116	35,116	35,895	35,895	35,895	35,895
	Golf Course Recharge	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
	Rainfall Recharge	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NERT Stormwater Retention Basins	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837	1,837
	NERT Recharge Trenches	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pioneer Detention Basin	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788	1,788
	Tuscany Golf Course/Weston Hill Subdrains	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600
	Athens Main Drainage Channel	22,281	31,102	21,599	19,433	16,991	23,036	25,920	28,076	28,221	26,494	28,798	31,102	35,414	35,927	39,867	38,564	38,308	31,923	33,123	38,308	32,340
	TIMET Injection	5,130	4,302	4,911	5,418	5,888	6,300	6,021	6,191	6,782	6,091	6,160	6,735	7,429	8,374	8,952	8,666	8,021	7,639	7,235	7,259	7,060
	OSSM Injection	27,896	29,517	28,233	26,822	27,014	27,463	27,399	27,143	27,463	26,822	24,448	25,474	26,629	25,538	25,923	28,169	29,196	27,784	28,875	28,041	31,313
	Total Inflow (cfd)	**1,070,000**	**1,080,000**	**1,070,000**	**1,080,000**	**1,040,000**	**1,050,000**	**1,090,000**	**1,100,000**	**1,100,000**	**1,070,000**	**1,180,000**	**1,100,000**	**1,180,000**	**1,180,000**	**1,120,000**	**1,170,000**	**1,150,000**	**1,170,000**	**1,190,000**	**1,210,000**	**1,210,000**
Groundwater Outflow	Groundwater Extraction (Total)	320,342	306,124	325,520	327,370	322,352	337,205	337,922	334,037	313,042	331,337	337,719	353,338	318,565	374,853	396,576	431,741	430,431	684,718	723,280	494,419	418,996
	NERT (IWF)	13,735	13,895	14,281	13,435	13,326	13,470	12,697	12,146	11,205	10,681	13,020	11,418	11,628	12,551	12,499	12,187	11,745	11,865	11,443	10,546	10,749
	NERT (AWF)	54,395	53,814	54,341	55,327	54,098	53,991	54,313	53,751	51,087	48,336	52,011	64,175	56,959	76,939	74,963	87,694	88,848	89,572	89,352	89,225	90,682
	NERT (SWF)	97,733	96,668	94,041	99,446	100,776	110,322	104,718	107,461	97,765	103,471	105,188	107,219	92,795	120,822	131,171	150,443	147,276	143,317	143,347	141,528	142,972
	NERT (AP Area Wells)	0	-	-	-	-	-	-	-	-	-	-	-	226	960	1,068	1,669	2,254	2,080	1,818	1,641	1,579
	NERT (Seep Sump)	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	OSSM	27,896	29,517	28,233	26,822	27,014	27,463	27,399	27,143	27,463	26,822	24,448	25,474	26,629	25,538	25,923	28,169	29,196	27,784	28,875	28,041	31,313
	AMPAC/Endeavour	121,453	107,929	129,713	126,922	121,249	125,658	132,774	127,345	118,740	135,937	136,893	138,318	122,898	129,668	142,001	142,912	143,092	143,207	141,212	129,135	134,641
	TIMET	5,130	4,302	4,911	5,418	5,888	6,300	6,021	6,191	6,782	6,091	6,160	6,735	7,429	8,374	8,952	8,666	8,021	7,639	7,235	7,259	7,060
	Weir Dewatering (Sunrise Mountain)	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	150,301	201,245	87,044	0
	Weir Dewatering (Historic Lateral)	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	108,953	98,753	0	0
	Groundwater Discharge to the Wash	517,038	622,538	466,963	450,179	526,212	605,770	461,323	451,631	542,952	626,960	489,831	475,403	580,896	668,684	497,308	471,680	548,835	308,635	117,418	242,942	480,188
	Eastgate Storm Drain	17,160	17,084	17,046	17,159	17,315	17,284	17,601	17,914	18,131	18,327	18,583	18,587	18,504	18,382	18,260	18,194	18,047	17,936	17,883	18,036	18,018
	Athens Drainage Channel	7,251	7,353	7,141	7,155	7,335	7,563	7,822	8,036	8,266	8,418	8,759	8,878	9,132	9,292	9,061	9,078	9,060	9,238	9,263	9,583	9,864
	Weston Hill/Golf Course Subdrains	8,706	8,880	8,690	8,606	8,683	8,855	8,682	8,602	8,687	8,879	8,704	8,628	8,721	8,978	8,775	8,697	8,778	7,768	7,101	7,355	7,856
	Eastern Boundary Outflow Beneath the Wash	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
	Evapotranspiration	172,633	29,342	283,729	256,961	125,002	28,950	281,872	257,020	127,909	29,649	295,044	265,996	133,940	31,222	296,779	265,802	129,195	23,946	193,285	213,393	123,747
	Total Outflow (cfd)	**1,070,000**	**1,020,000**	**1,130,000**	**1,090,000**	**1,030,000**	**1,030,000**	**1,140,000**	**1,100,000**	**1,040,000**	**1,050,000**	**1,180,000**	**1,160,000**	**1,090,000**	**1,140,000**	**1,250,000**	**1,230,000**	**1,170,000**	**1,080,000**	**1,090,000**	**1,010,000**	**1,080,000**
Change in Storage, Inflow minus Outflow (cfd)		**--**	**60,000**	**-60,000**	**-10,000**	**10,000**	**20,000**	**-50,000**	**0**	**60,000**	**20,000**	**0**	**-60,000**	**90,000**	**40,000**	**-130,000**	**-60,000**	**-20,000**	**90,000**	**100,000**	**200,000**	**130,000**

Notes:
cfd = cubic feet per day
-- = Not Applicable
AWF = Athens Road Well Field
IWF = Interceptor Well Field
SWF = Seep Well Field
AMPAC = American Pacific Corporation (now Endeavour, LLC)
NERT = Nevada Environmental Response Trust
OSSM = Olin Chlor-Alkali/Stauffer/Syngenta/Montrose
TIMET = Titanium Metals Corporation
The total inflow and outflow values have been rounded to three significant figures, after calculations.

TABLE 7. CALIBRATION STATISTICS FOR FLOW MODEL
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Parameter	Head Target (All Layers)	Head Target (Layers 9 and 10)
Residual Mean (ft)	-3.02	10.1
Root Mean Square Error (ft)	5.9	16.1
Standard Deviation (ft)	5.2	12.6
Range of Observations (ft)	435	339
Residual Sum of Squares (ft^2)	2.3×10^5	2.6×10^4
Number of Observations	6,656	99

Notes:

ft = feet
ft^2 = square feet

TABLE 8. SENSITIVITY ANALYSIS OF FLOW MODEL RESULTS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Input Parameter	Sensitivity Analysis Value		Sum of Squared Residuals (ft^2)	Groundwater Elevation (ft)		Difference from LVW Discharge, RMSE (cfs)
	Calibrated Model	Multiplier		RMSE	RM	
Horizontal Hydraulic Conductivity of Alluvium Outside of Paleochannels	45 ft/d	0.75	2.70×10^5	6.38	-3.73	2.26
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.06×10^5	5.57	-2.53	2.13
Vertical Hydraulic Conductivity of Alluvium Outside of Paleochannels	0.4 ft/d	0.75	2.30×10^5	5.88	-3.03	2.19
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.29×10^5	5.87	-3.02	2.19
Horizontal Hydraulic Conductivity of Alluvium Within Paleochannels	175 - 700 ft/d	0.75	2.93×10^5	6.64	-3.88	2.50
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	1.93×10^5	5.39	-2.36	1.95
Vertical Hydraulic Conductivity of Alluvium Within Paleochannels	17.5 - 70 ft/d	0.75	2.30×10^5	5.88	-3.03	2.19
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.30×10^5	5.88	-3.03	2.19
Horizontal Hydraulic Conductivity of UMCf-fg	0.72 ft/d	0.75	2.65×10^5	6.31	-3.64	2.26
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.03×10^5	5.52	-2.45	2.13
Vertical Hydraulic Conductivity of UMCf-fg	0.01 ft/d	0.75	2.31×10^5	5.89	-3.10	2.19
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.28×10^5	5.86	-2.97	2.18
Horizontal Hydraulic Conductivity of UMCf-cg	Various	0.75	2.62×10^5	6.28	-3.58	2.18
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.09×10^5	5.61	-2.51	2.19
Vertical Hydraulic Conductivity of UMCf-cg	Various	0.75	2.23×10^5	5.79	-2.97	2.19
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.37×10^5	5.97	-3.11	2.19
Surface Recharge Rates	Various	0.75	1.82×10^5	5.23	-2.13	2.67
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.90×10^5	6.60	-3.88	1.75
Streambed Hydraulic Conductivity	Various	0.75	2.31×10^5	5.91	-3.03	2.18
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.28×10^5	5.88	-3.01	1.97
Specific Storage	Various	0.75	2.30×10^5	5.88	-3.02	2.19
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.30×10^5	5.88	-3.03	2.19
Specific Yield	Various	0.75	2.30×10^5	5.88	-3.01	2.22
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.29×10^5	5.87	-3.03	2.16
Southern Boundary Inflow	402,419 cfd	0.75	1.52×10^5	4.77	0.32	2.85
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	4.48×10^5	8.21	-5.89	1.74
Western Boundary Inflow	229,400 cfd	0.75	2.29×10^5	5.87	-3.00	3.03
		1	2.30×10^5	5.88	-3.02	1.91
		1.25	2.30×10^5	5.89	-3.05	1.40

TABLE 8. SENSITIVITY ANALYSIS OF FLOW MODEL RESULTS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Input Parameter	Sensitivity Analysis Value		Sum of Squared Residuals (ft^2)	Groundwater Elevation (ft)		Difference from LVW Discharge, RMSE (cfs)
	Calibrated Model	Multiplier		RMSE	RM	
Evapotranspiration Rate	Various	0.75	2.31×10^5	5.90	-3.06	1.78
		1	2.30×10^5	5.90	-3.02	1.91
		1.25	2.28×10^5	5.86	-2.99	2.58

Notes:
ft = feet
ft^2 = square feet
ft/d = feet per day
cfd = cubic feet per day
cfs = cubic feet per second
LVW = Las Vegas Wash
RM = residual mean
RMSE = root mean square error
UMCf-fg = Fine-grained Upper Muddy Creek Formation
UMCf-cg = Coarse-grained Upper Muddy Creek Formation
Calibration statistics of calibrated model are highlighted

TABLE 9. CONCEPTUAL PERCHLORATE MASS REMOVAL SUMMARY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Mass Removal Component	**2014**				**2015**				**2016**				**2017**				**2018**			
	Q1	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Mass Removal via Extraction (lbs/d)	2,424	2,724	2,689	2,434	2,533	2,725	2,388	2,272	2,187	2,336	2,204	1,985	2,216	2,196	2,240	2,240	2,046	2,133	1,881	1,940
NERT (IWF) [a]	899	839	856	766	782	734	634	598	471	573	481	528	582	516	497	500	457	459	384	407
NERT (AWF) [a]	496	447	519	510	537	562	514	543	401	443	424	410	496	405	450	471	429	475	426	444
NERT (SWF) [a]	51	47	63	64	77	72	73	71	69	67	68	62	64	70	86	87	60	52	73	70
AP Wells [a]	0	0	0	0	0	0	0	0	0	0	0	28	87	58	83	113	104	109	91	93
OSSM [b]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
AMPAC/Endeavour [c]	977	1,392	1,252	1,093	1,136	1,357	1,167	1,060	1,247	1,253	1,230	956	989	1,147	1,125	1,069	996	1,039	907	926
TIMET [b]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mass Removed Via Weir Dewatering (lbs/d) [d]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	25	30	11	0
Mass Discharge to the Wash (lbs/d) [e]	79	78	67	69	79	70	78	89	86	84	81	81	88	76	65	77	73	49	57	68
Mass Discharge via Athens Mains (lbs/d) [c]	14	11	16	8	12	14	10	10	14	13	14	11	16	17	14	22	16	16	17	11
Mass Discharge via Golf Course Sub-drains (lbs/d) [f]	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Mass Leaving the Model Domain at the Eastern Boundary (lbs/d) [g]	2.4	1.9	2.1	2.2	2.5	2.3	2.3	2.3	2.6	1.6	2.3	2.3	2.5	2.2	1.9	2.1	2.3	2.0	2.0	2.2
Combined Mass Removal (lbs/d)	**2,503**	**2,802**	**2,756**	**2,503**	**2,612**	**2,795**	**2,465**	**2,361**	**2,273**	**2,420**	**2,285**	**2,066**	**2,304**	**2,273**	**2,304**	**2,317**	**2,144**	**2,212**	**1,950**	**2,008**

Notes:

lbs/d = pounds per day
-- = Not Applicable
AWF = Athens Road Well Field
IWF = Interceptor Well Field
SWF = Seep Well Field
AMPAC = American Pacific Corporation (now Endeavour, LLC)
NERT = Nevada Environmental Response Trust
OSSM = Olin Chlor-Alkali/Stauffer/Syngenta/Montrose
TIMET = Titanium Metals Corporation

[a] Based on the values presented in the Ramboll Annual Performance Reports
[b] Perchlorate removal is not estimated
[c] Based on the values and/or figures presented in the AMPAC/Endeavor Monitoring Reports
[d] Based on the values reported by Tetra Tech in their monthly dewatering reports.
[e] Estimated using streamflow and perchlorate concentrations in the Wash
[f] Estimated from data collected from November 2018 through July 2019 as part of RI Phase 3, Modification #2.
[g] Estimated from average perchlorate concentrations measured at wells WMW3.5S and WMW3.5N. Data for 2014 only included WMW3.5S samples, so the quarterly averages for 2014 reflects the respective quarterly averages from 2015 through 2018.

TABLE 10. TRANSPORT MODEL PARAMETERS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Transport Parameter	Model Layer	Value	Unit
Longitudinal Dispersivity	All Layers	60	ft
Diffusion Coefficient	All Layers	1.53×10^{-3}	ft^2/d
Mass Transfer Coefficient	Layer 1	2.25×10^{-4}	per day
	Layers 2 through 10 (except UMCf-cg)	6.85×10^{-4}	per day
	Layers 2 through 9 (UMCf-cg)	2.25×10^{-4}	per day
Total Porosity	Layer 1	0.37	--
	Layer 2 through 10	0.54	--
Immobile Porosity	Layer 1	0.27	--
	Layer 2 (xMCf)	0.33	--
	Layers 3 through 10 (UMCf-fg)	0.34	--
	Layers 3 through 10 (UMCf-cg)	0.30	--

Notes:
ft = feet
ft^2/d= square feet per day
UMCf-cg = Coarse-grained Upper Muddy Creek Formation
UMCf-fg = Fine-grained Upper Muddy Creek Formation
xMCf = Transitional Muddy Creek Formation
The mobile porosities are same as specific yield presented in Table 4.

TABLE 11. CALIBRATION STATISTICS FOR TRANSPORT MODEL
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Parameter	Concentration Target
Residual Mean (mg/l)	-0.57
Root Mean Square Error (mg/l)	120.5
Standard Deviation (mg/l)	120.5
Range of Observations (mg/l)	6,600
Residual Sum of Squares ($[mg/l]^2$)	6.61 X 10^7
Number of Observations	4,548

Notes:

mg/l = milligram per liter
$[mg/l]^2$ = milligram per liter, squared

TABLE 12. SENSITIVITY ANALYSIS OF TRANSPORT MODEL RESULTS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Input Parameter	Sensitivity Analysis Value		Sum of Squared Residuals ($[mg/l]^2$)	Perchlorate Concentration in Groundwater (mg/l)		Mass Loading in the Wash, RMSE (lbs/d)	Mass Removal from Extraction Wells, RMSE (lbs/d)
	Calibrated Model	Multiplier		RMSE	RM		
Dispersivity	60 ft	0.75	6.63×10^7	120.81	-0.20	11.0	140
		1	6.61×10^7	120.54	-0.57	11.3	146
		1.25	6.62×10^7	120.65	-0.77	11.8	129
Mass Transfer Rate	2.25×10^{-4} - 6.75×10^{-4} per day	0.75	6.60×10^7	120.46	2.69	12.1	201
		1	6.61×10^7	120.54	-0.57	11.3	146
		1.25	6.68×10^7	121.25	-2.77	11.3	106
Porosity	Variable	0.75	6.88×10^7	122.99	3.90	11.7	170
		1	6.61×10^7	120.54	-0.57	11.3	146
		1.25	6.56×10^7	120.14	-3.39	11.0	156

Notes:

ft = feet

lbs/d = pounds per day

mg/l = milligrams per liter

$[mg/l]^2$ = milligram per liter, squared

RM = residual mean

RMSE = root mean square error

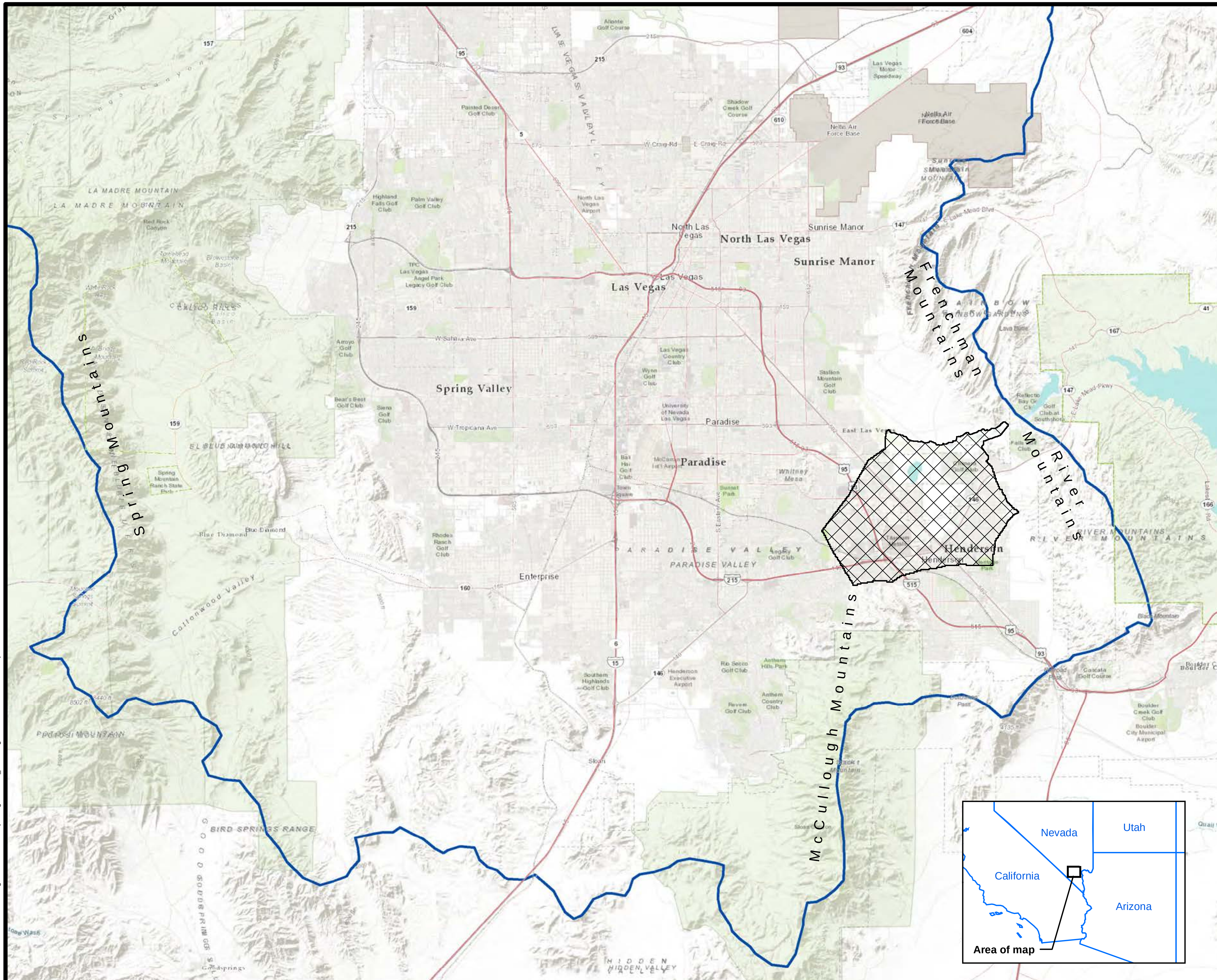
Calibration statistics of calibrated model are highlighted

TABLE 13. MODELED PERCHLORATE MASS REMOVAL SUMMARY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Mass Removal Component	2014				2015				2016				2017				2018			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Mass Removal via Extraction (lbs/d)	2,490	2,518	2,440	2,415	2,411	2,407	2,237	2,138	2,213	2,312	2,255	2,057	2,041	2,268	2,221	2,282	2,250	2,199	2,004	1,948
NERT (IWF)	931	1,004	967	935	875	786	725	659	605	673	579	561	570	544	481	510	465	438	393	387
NERT (AWF)	468	264	265	280	293	295	298	309	305	312	359	327	399	410	435	438	432	429	429	432
NERT (SWF)	48	60	80	84	89	96	102	96	97	113	105	98	103	122	121	134	114	109	101	85
AP Wells	0	0	0	0	0	0	0	0	0	0	0	7	29	30	45	38	41	36	31	29
OSSM	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
AMPAC/Endeavour	1,040	1,187	1,127	1,115	1,151	1,227	1,110	1,071	1,204	1,212	1,210	1,062	938	1,160	1,137	1,159	1,126	1,106	1,020	1,012
TIMET	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	78	28	0
Mass Removal Via Weir Dewatering (lbs/d)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	83	91	32	0
Mass Discharge to the Wash (lbs/d)	74	61	65	69	71	66	65	70	73	67	68	75	82	72	73	78	52	37	45	59
Mass Discharge via Athens Mains (lbs/d)	17	15	14	13	13	12	12	12	12	12	11	11	11	11	10	10	10	10	10	9
Mass Discharge via Golf Course Sub-drains (lbs/d)	4.3	4.5	4.6	4.5	4.6	4.4	4.3	4.3	4.3	4.2	4.2	4.2	4.3	4.2	4.1	4.1	3.7	3.4	3.4	3.6
Mass Leaving the Model Domain at the Eastern Boundary (lbs/d)	3.0	3.0	2.9	3.2	3.0	2.6	2.6	2.6	2.3	2.3	2.2	2.3	2.1	1.9	2.0	2.0	1.8	1.8	1.8	3.4
Modeled Mass Removal (lbs/d)	**2,589**	**2,602**	**2,527**	**2,505**	**2,502**	**2,492**	**2,321**	**2,226**	**2,304**	**2,397**	**2,340**	**2,150**	**2,140**	**2,357**	**2,311**	**2,376**	**2,400**	**2,342**	**2,096**	**2,024**

Notes:
lbs/d = pounds per day
AWF = Athens Road Well Field
IWF = Interceptor Well Field
SWF = Seep Well Field
AMPAC = American Pacific Corporation (now Endeavour, LLC)
NERT = Nevada Environmental Response Trust
OSSM = Olin Chlor-Alkali/Stauffer/Syngenta/Montrose
TIMET = Titanium Metals Corporation

FIGURES



EXPLANATION

- Phase 6 Model Extent
- Las Vegas Valley Hydrologic Basin

N

0 2.5 5 Miles

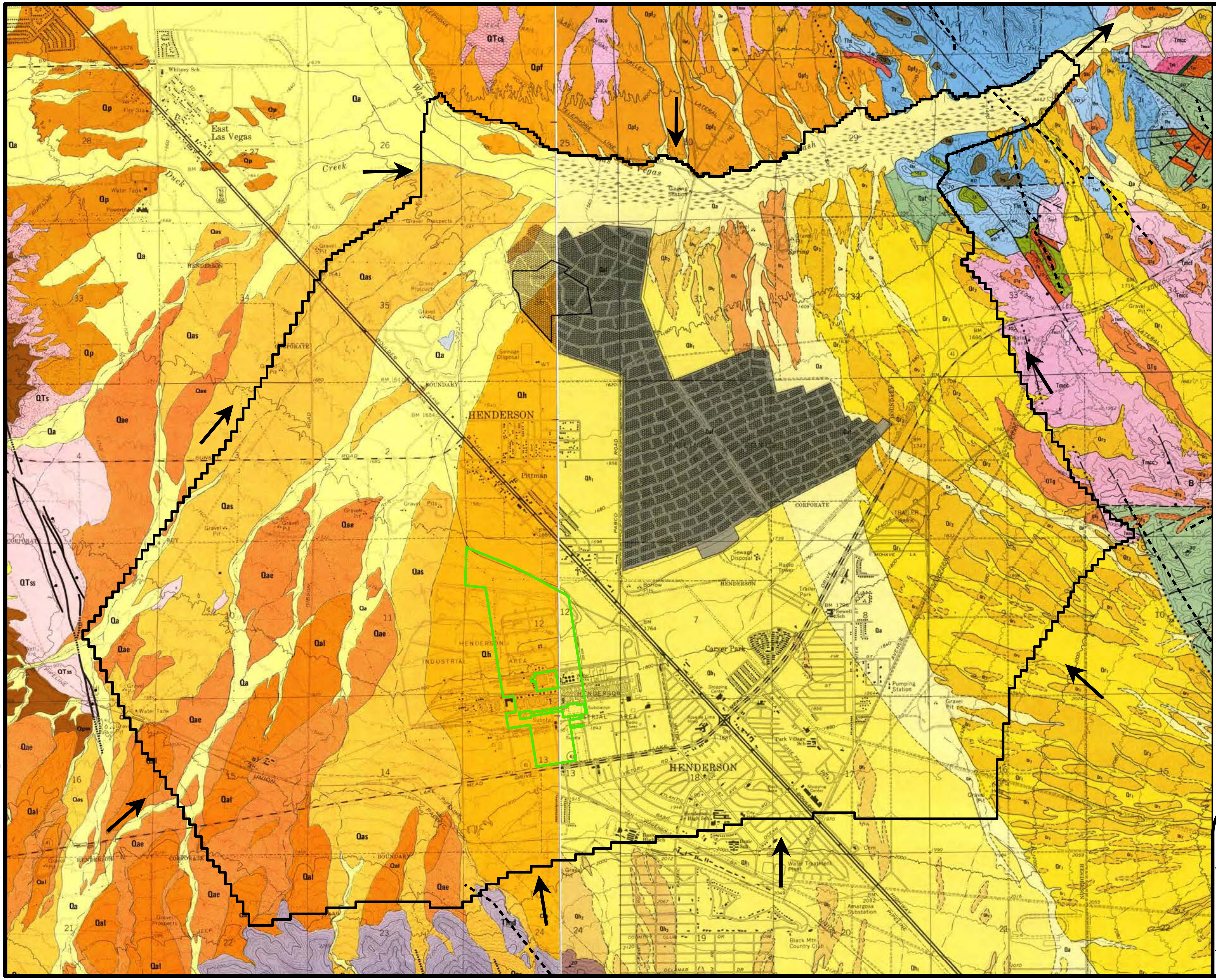
RAMBOLL

MODEL LOCATION MAP

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 1-1
Drafter: AS	Approved:	Revised:	

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 1-1 - Model Location Map.mxd



EXPLANATION

- Phase 6 Model Extent
- Geologic Faults
- NERT Property Boundary
- Direction of Groundwater Flow

Primary Lithologies

Qa, Qma, Qsa, Qd, Qpf, Qp, Qas, Qh, Qae, Qal, Qpw, Qpm, Qagf — Alluvium, including Paleochannels and Wash Gravels

Tmd — Upper Muddy Creek Formation

Ths, Tt — Horse Spring/ Other Formation

Tmcc — Volcanic and Conglomerate Rocks

Geological Map Reference:
Bingler, E. C. 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

0 0.5 1 Mile

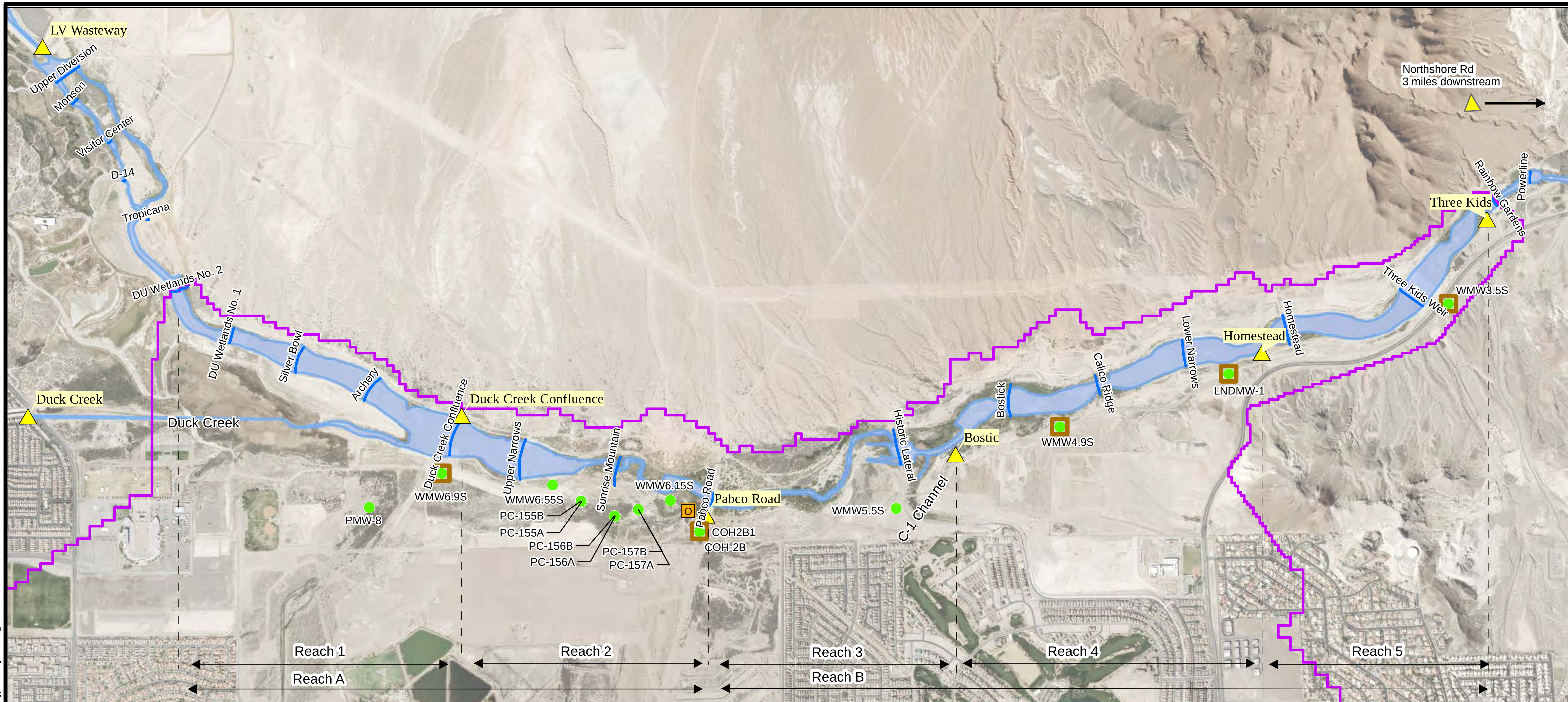
N

RAMBOLL

MODEL AREA:
GEOLOGY AND GROUNDWATER FLOW
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 2-1
Drafter: AS	Approved:	Revised:	

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 2-1 - Model Area- Geology and Groundwater Flow.mxd



EXPLANATION

- AECOM Transducer Location
- Wells Considered in Conceptual Water Balance
- USGS
- NERT/AMPAC (Endeavour) /TIMET/COH Outfall Location
- SNWA Weirs
- Phase 6 Model Extent
- Las Vegas Wash (2017)

Note: Clark County 4-band digital aerials for March 2017 are shown, image courtesy of SNWA.

NERT = Nevada Environmental Response Trust
AMPAC = American Pacific Corporation, now Endeavour LLC
TIMET = Titanium Metals Corporation
COH = City of Henderson
SNWA = Southern Nevada Water Authority
USGS = United States Geological Survey

N

0 0.5 1 Mile

RAMBOLL

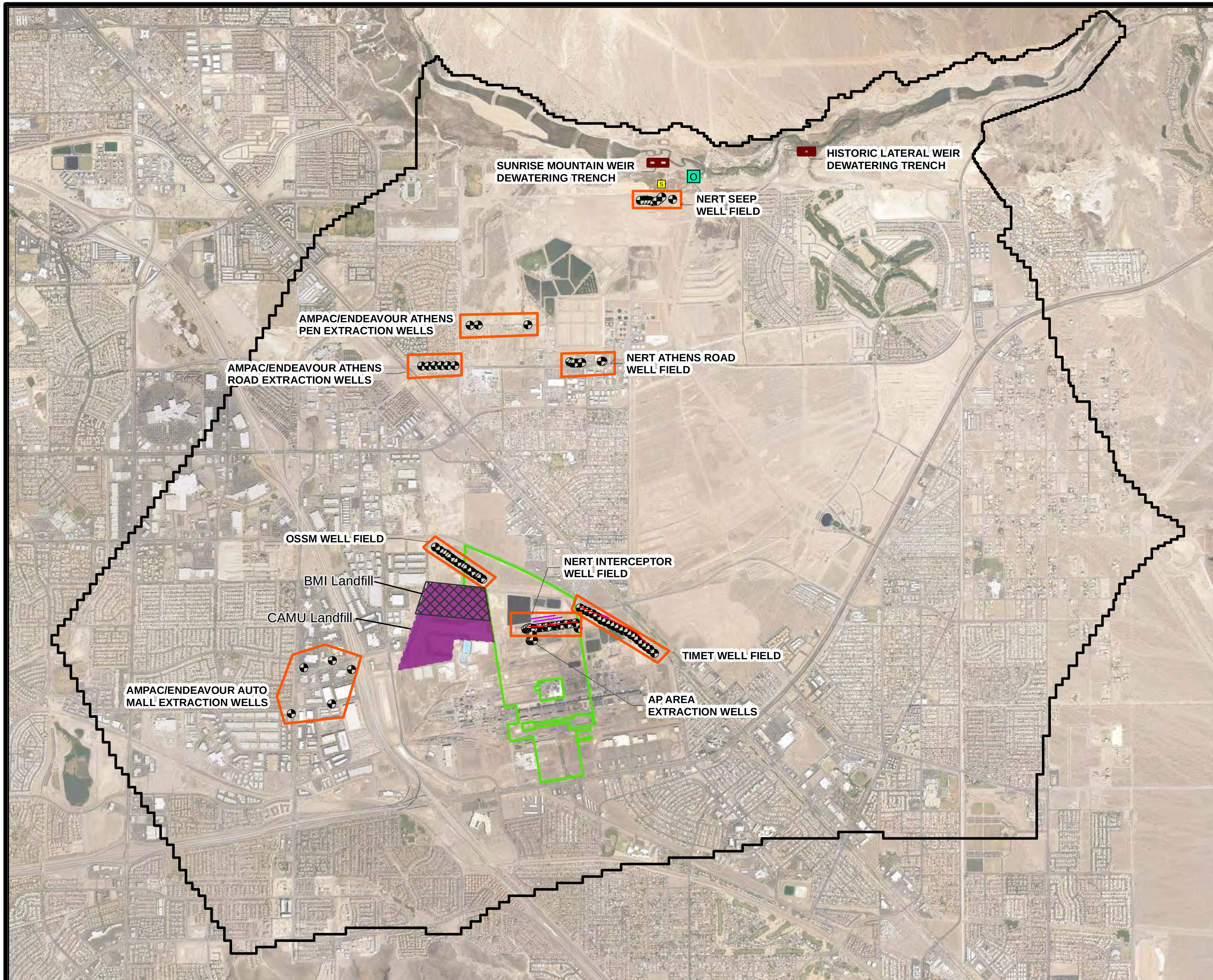
LAS VEGAS WASH AND OTHER HYDROLOGY FEATURES

Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
2-2

DRAFTED BY: LR | Date: 11/19/2019 | Project:1690011200-034

H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 2-2 - Hydrology-Las Vegas Wash_R2.mxd



EXPLANATION

- Surface Flow Capture Sump (Not operational since 2007)
- Slurry Wall
- Dewatering Trench
- Pumping Wells
- NERT Recharge Trenches
- NERT / AMPAC (Endeavour) / TIMET / COH Outfall Location
- Phase 6 Model Extent
- NERT Property Boundary

NOTE:
AMPAC: American Pacific Corporation, now Endeavour LLC
COH: City of Henderson
NERT: Nevada Environmental Response Trust
TIMET: Titanium Metals Corporation

N

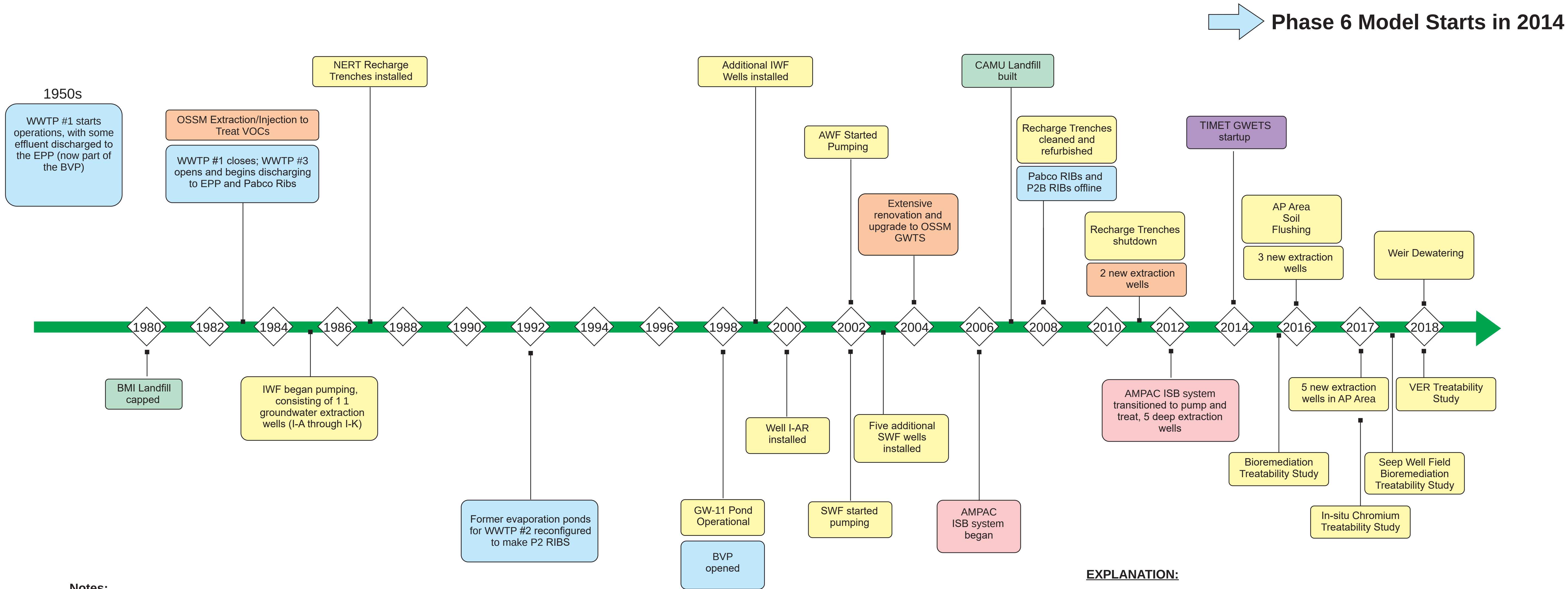
0 0.5 1 Miles

RAMBOLL

MODEL AREA FEATURES: REMEDIATION SYSTEM
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: AS	Approved:	Revised:	2-3

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 2-3 - Model Area Features - Remediation System.mxd



Notes:

AMPAC: American Pacific Corporation, now Endeavour LLC
AWF: Athens Well Field
BMI: Basic Management Incorporated
BVP: Bird Viewing Preserve
CAMU: Corrective Action Management Unit
COH: City of Henderson
EPP: Evaporation and Percolation Ponds
GWTS: Groundwater Treatment System
ISB: In-situ Bioremediation
IWF: Interceptor Well Field
NERT: Nevada Environmental Response Trust
OSSM: Olin/Stauffer/Syngenta/Montrose
RIB: Rapid Infiltration Basin
SWF: Seep Well Field
TIMET: Titanium Metals Corporation
VOC: Volatile Organic Compound
WWTP: Wastewater Treatment Plant

EXPLANATION:

- COH Ponds
- CAMU Landfill Area
- OSSM Remediation Events
- NERT Remediation Events
- AMPAC/Endeavour Remediation Events
- TIMET Remediation Events

RAMBOLL

TIMELINE FOR MAJOR REMEDIATION EVENTS IN THE MODEL DOMAIN
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
2-4

Drafter: RS | Date: 9/9/2019 | Contract Number: 1690011200-034 | Approved by: | Revised:

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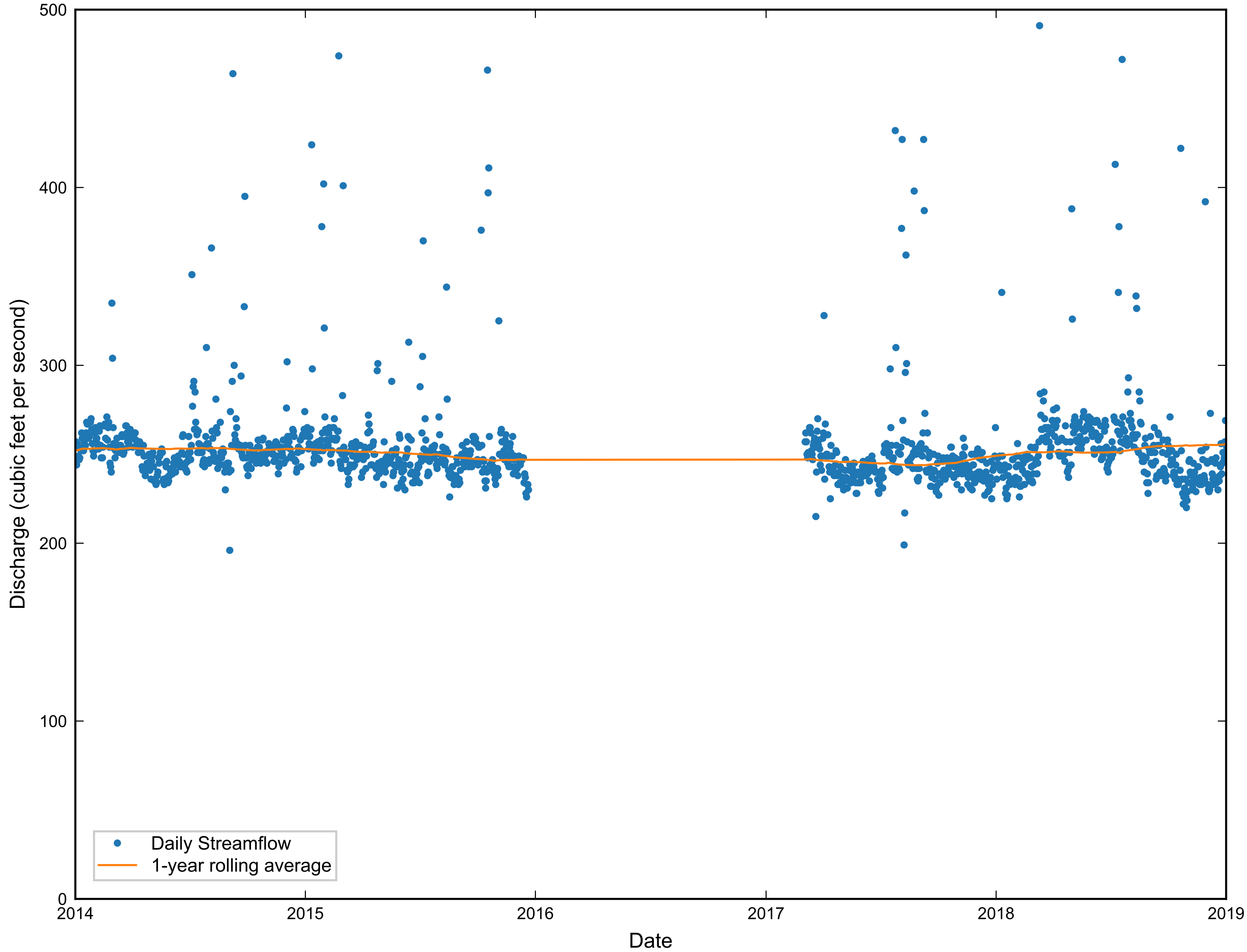


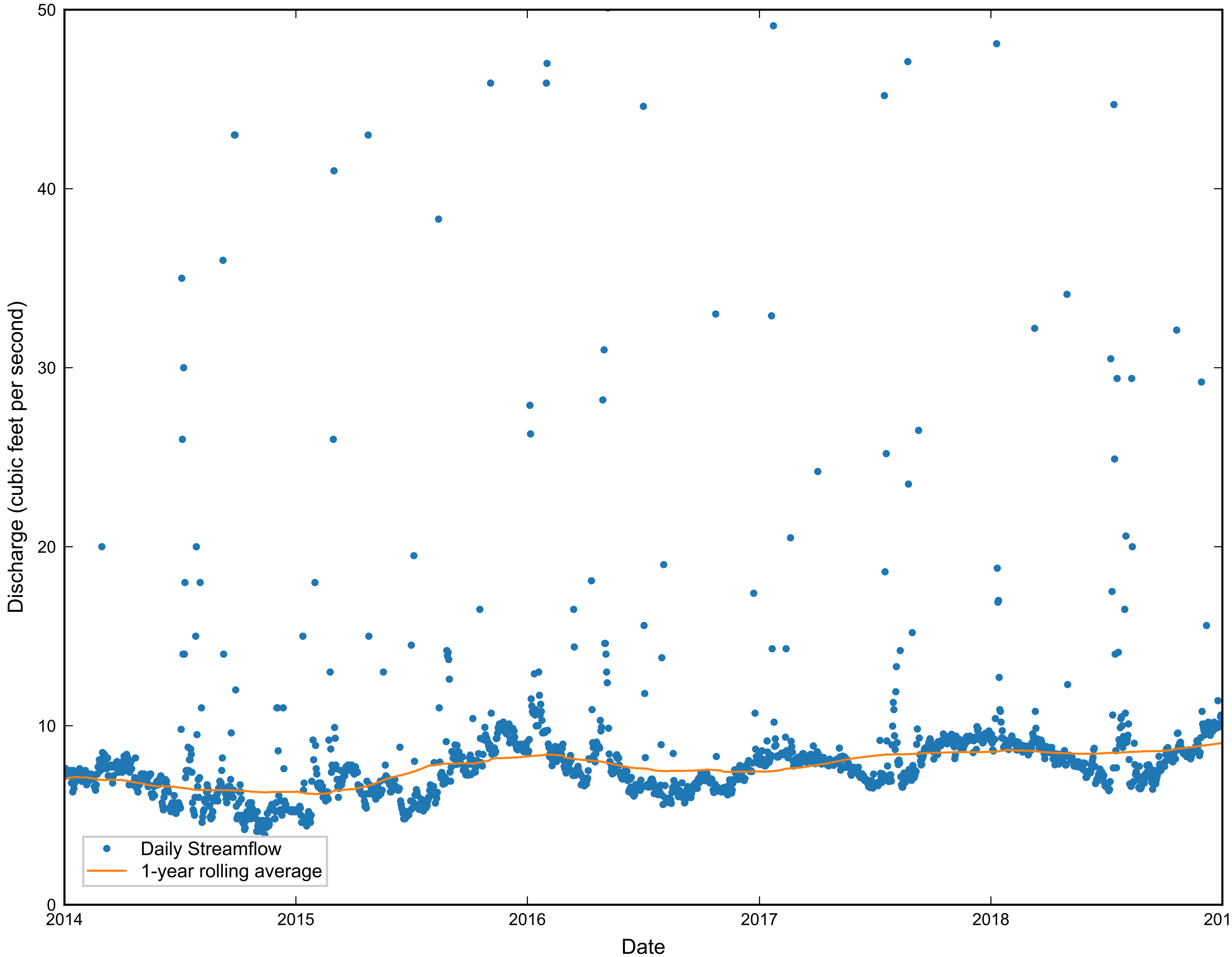
RAMBOLL

Streamflow at Las Vegas Wasteway Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-1

Drafter: RZ | Date: 11/19/19 | Contract Number: 1690011200-034 | Approved: | Revised:

ramboll\projects\NERT\Modeling\Phase_6\figures\LVW_station_discharge.py

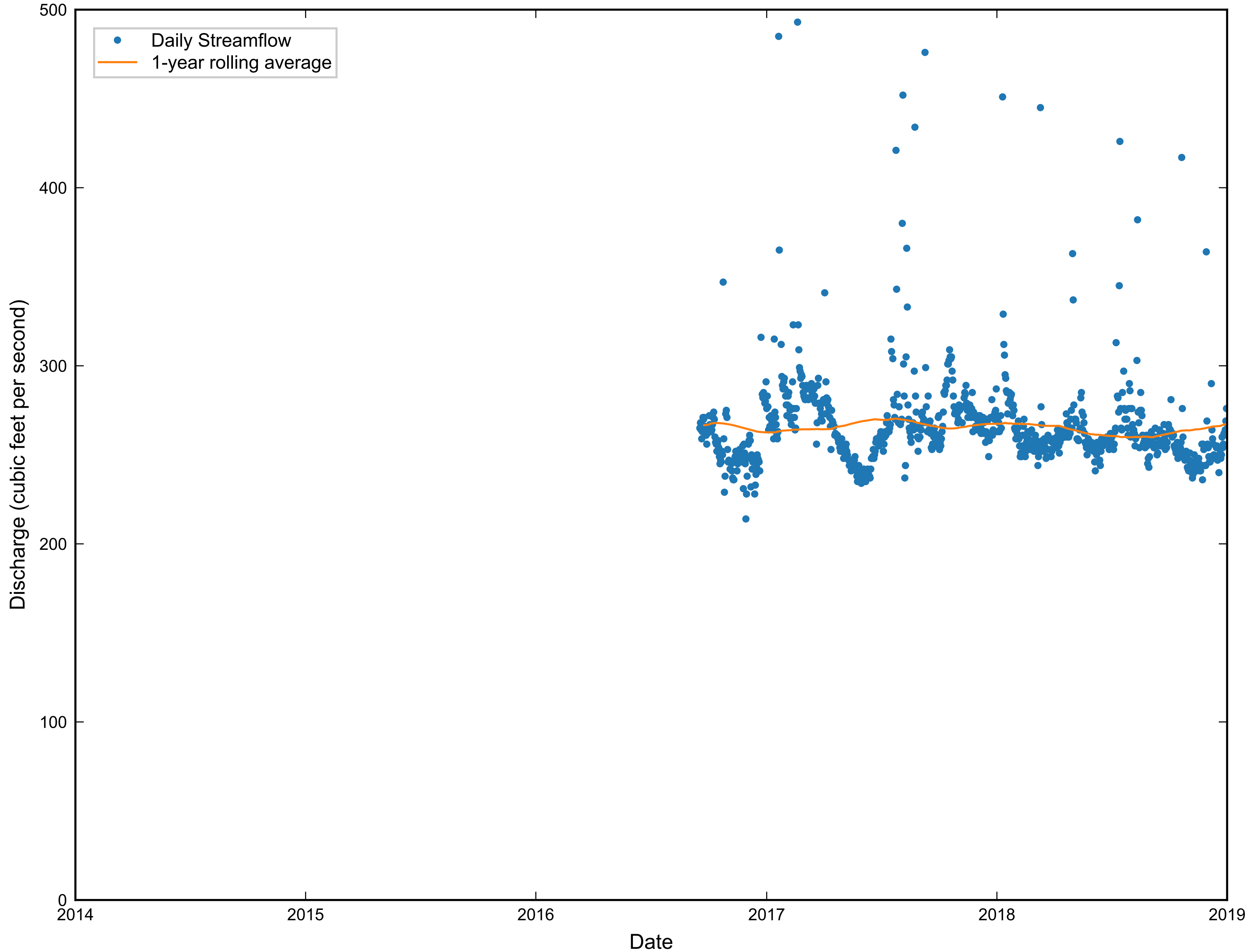


RAMBOLL

Streamflow at Duck Creek Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-2

Drafter: RZ | Date: 11/19/19 | Contract Number: 1690011200-034 | Approved: | Revised:



RAMBOLL

Streamflow at Duck Creek Confluence Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-3

Drafter: RZ | Date: 11/19/19 | Contract Number: 1690011200-034 | Approved: | Revised:

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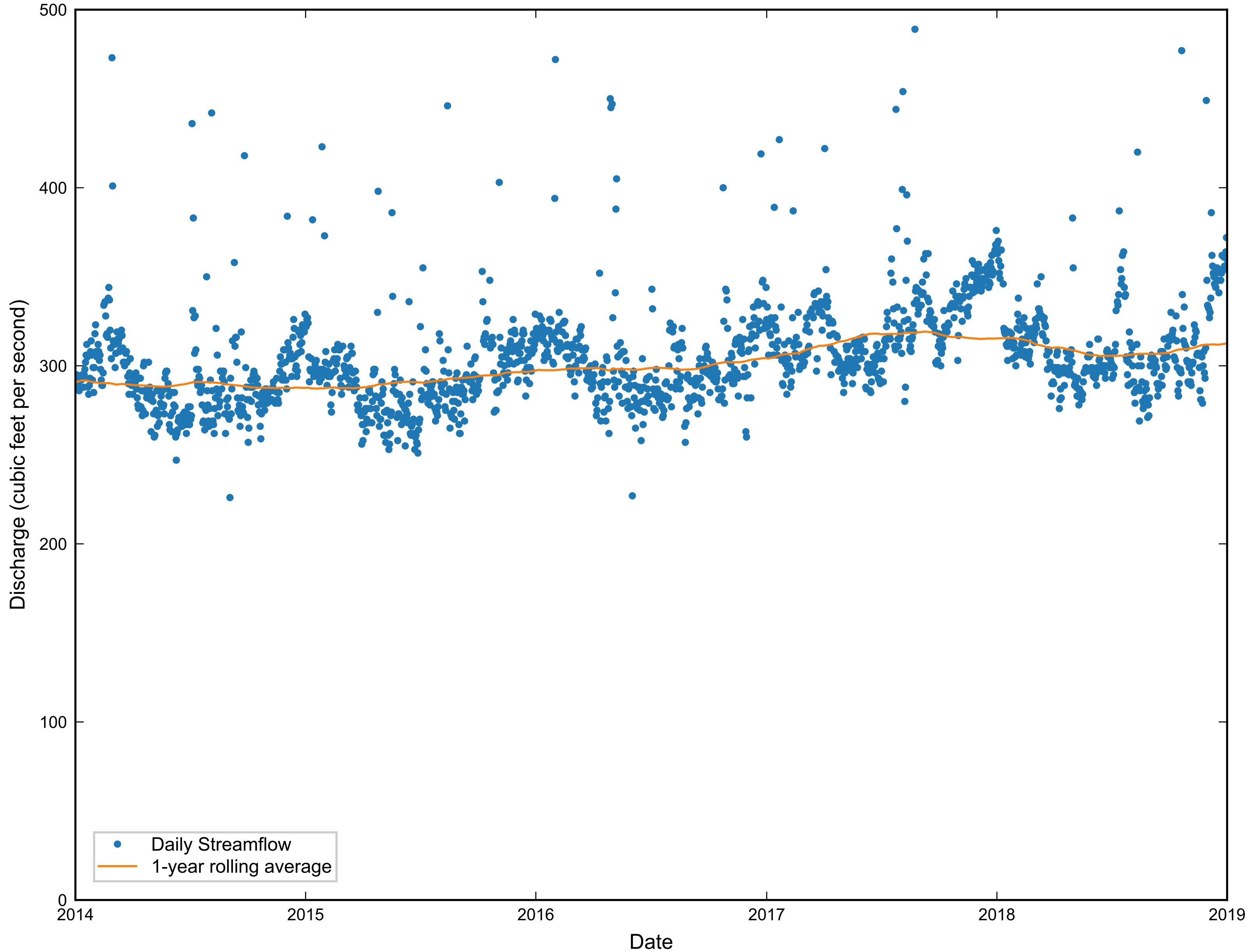

RAMBOLL

Streamflow at Pabco Road Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-4

Drafter: RZ	Date: 11/19/19	Contract Number: 1690011200-034	Approved:	Revised:

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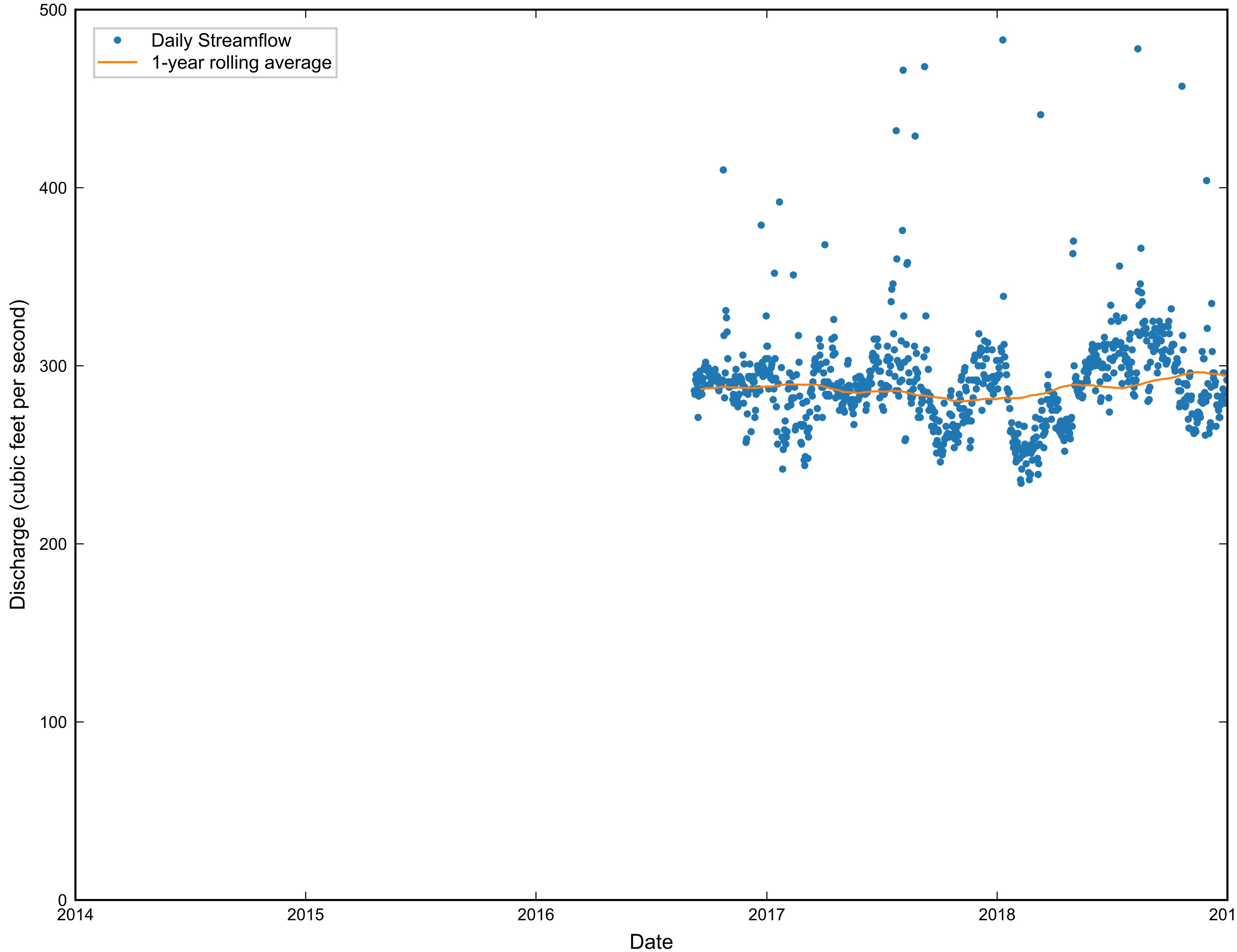

RAMBOLL

Streamflow at Bostic Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-5

Drafter: RZ | Date: 11/19/19 | Contract Number: 1690011200-034 | Approved: | Revised:

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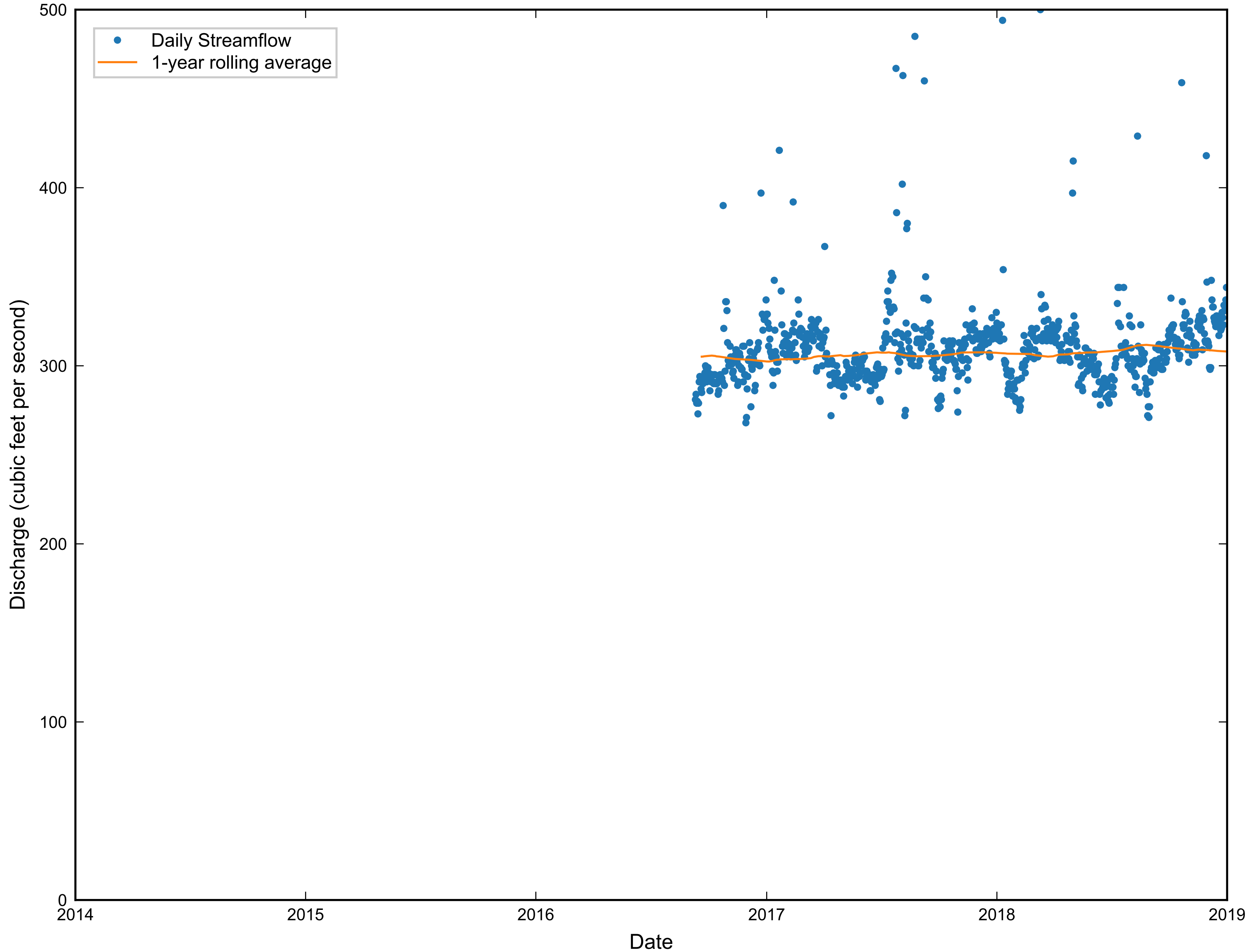

RAMBOLL

Streamflow at Homestead Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-6

Drafter: RZ | Date: 11/19/19 | Contract Number: 1690011200-034 | Approved: | Revised:

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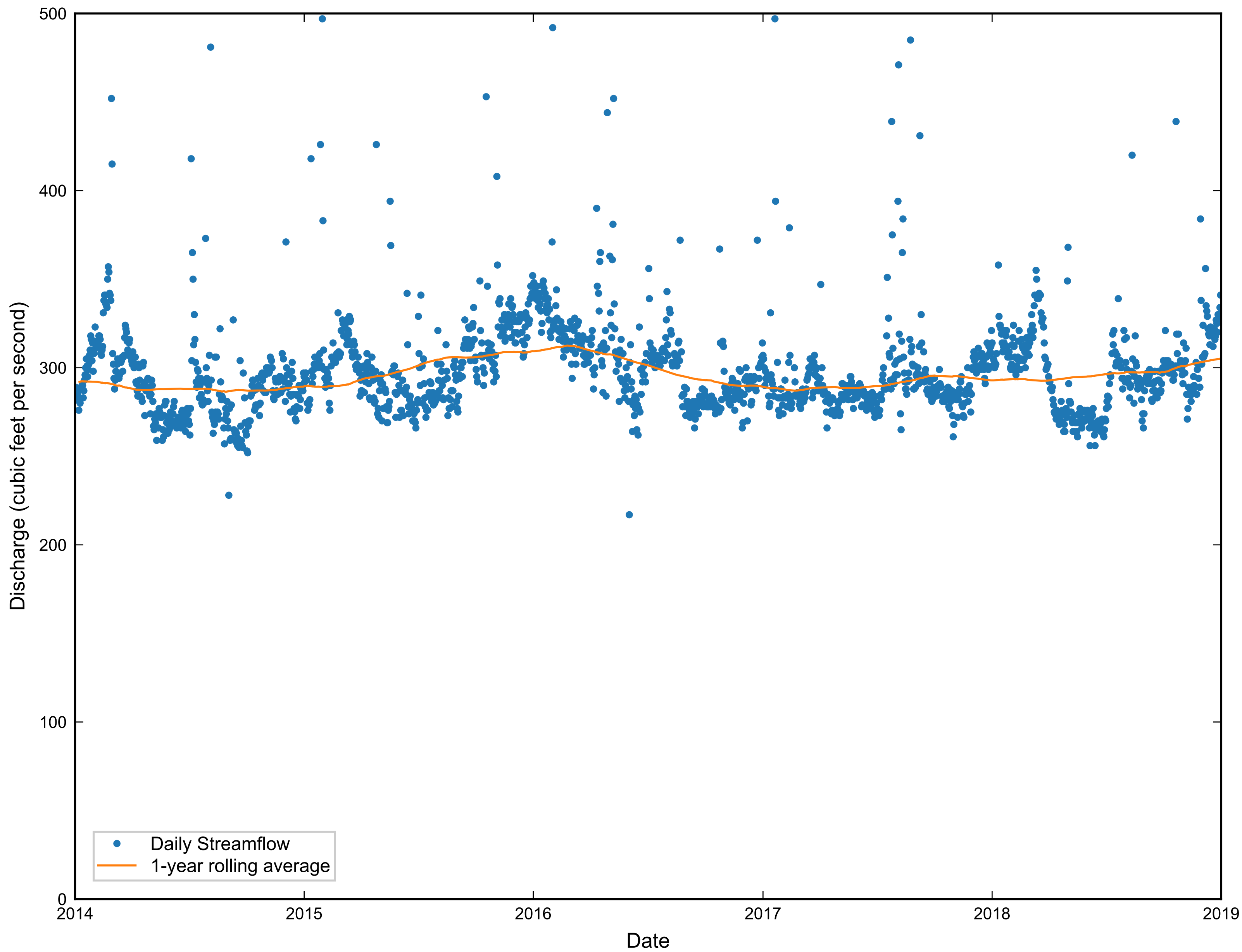
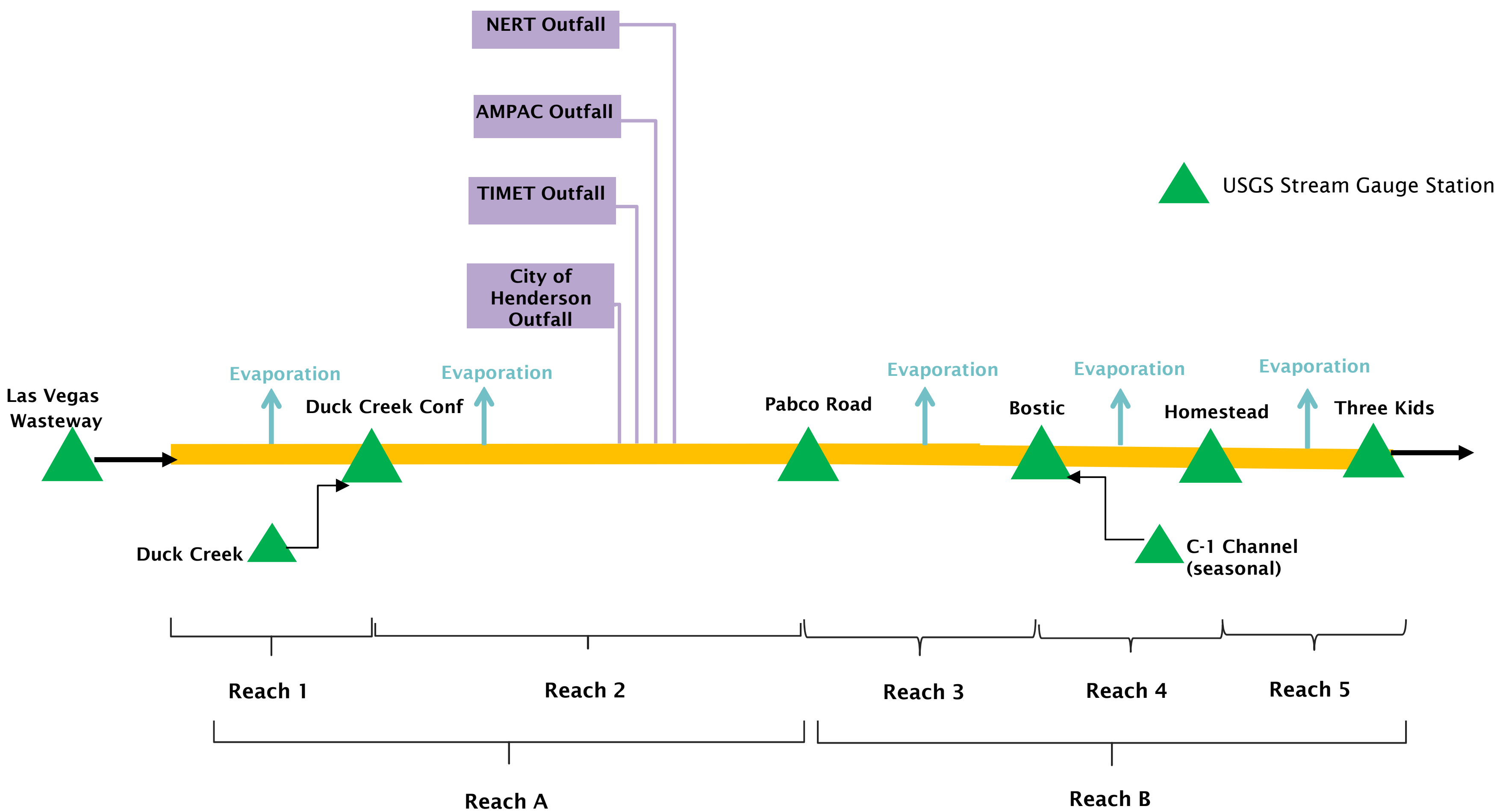


RAMBOLL

Streamflow at Three Kids Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-7

Drafter: RZ | Date: 11/19/19 | Contract Number: 1690011200-034 | Approved: | Revised:



Note: Figure not to scale

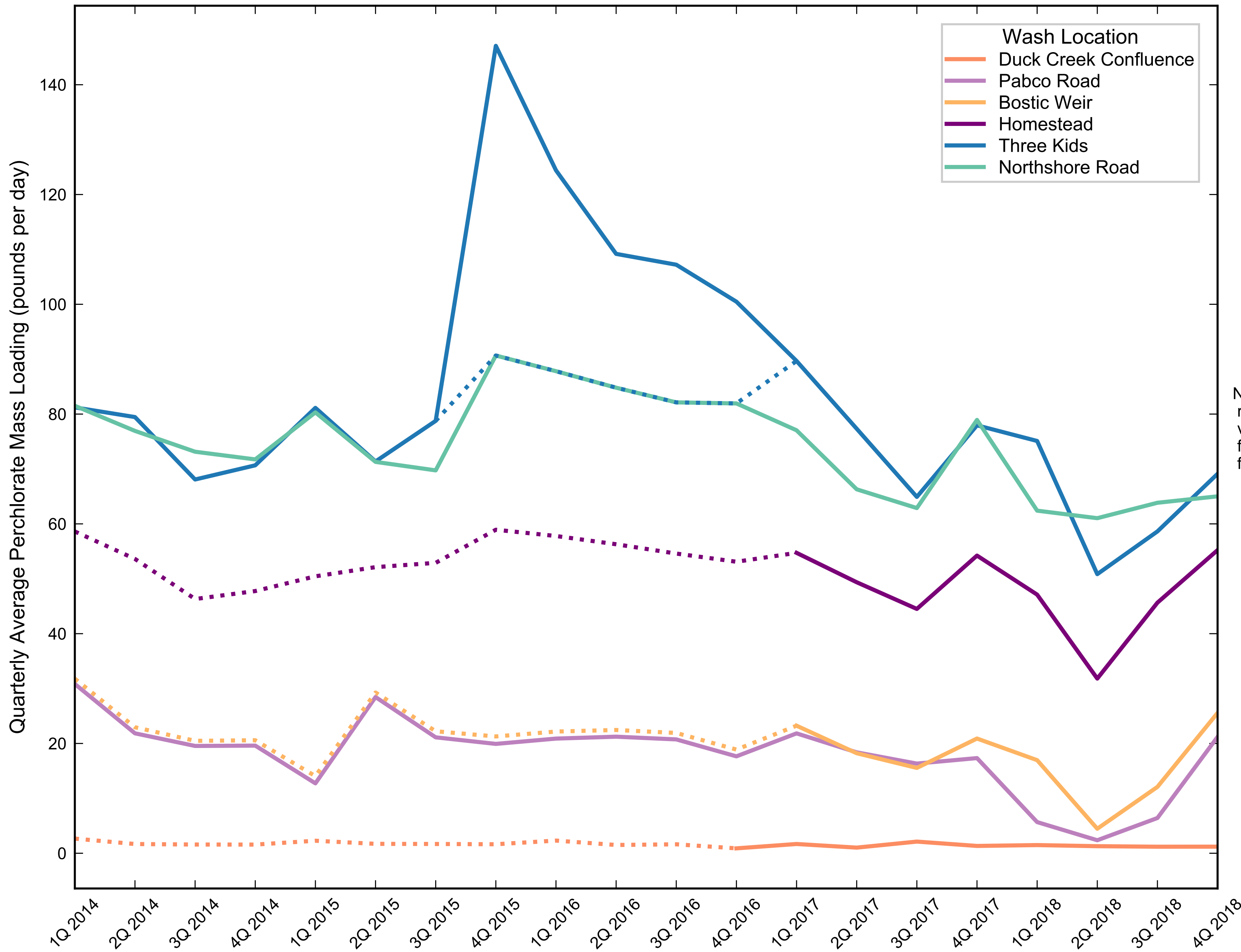
RAMBOLL

SCHEMATIC REPRESENTING VARIOUS LAS VEGAS WASH WATER BALANCE COMPONENTS
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure 3-8

DRAFTED BY: AS | 11/25/2019 | PROJECT: 1690011200-034

Path: \\wcevlfps1\ENG\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Draft_MXDs\Figure 2-11 - Loading at LVW\LVW_Loading_Figure.py



Note: Dashed lines represent estimated values. Please see footnotes in Table 1 for details.

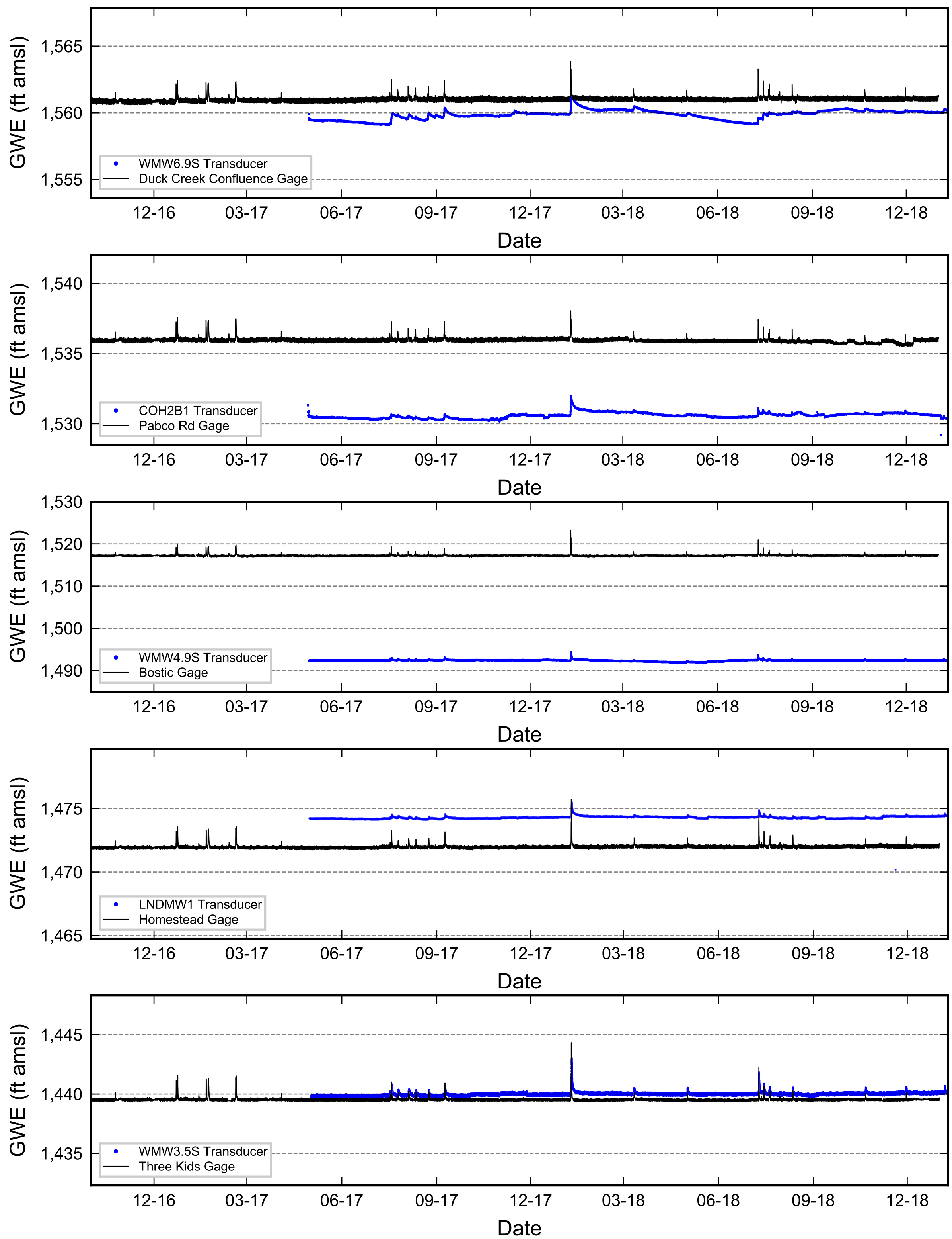
RAMBOLL

Perchlorate Mass Loading at the Las Vegas Wash
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-9

Drafter: MFS | Date: 10/28/19 | Contract Number: 1690011200-034 | Approved: | Revised:

Path: C:\Users\Public\Documents\Python Scripts\transducer_vs_GWE_v3_GWModel.py



Note:
GWE = Groundwater Elevation
ft amsl = feet above mean sea level

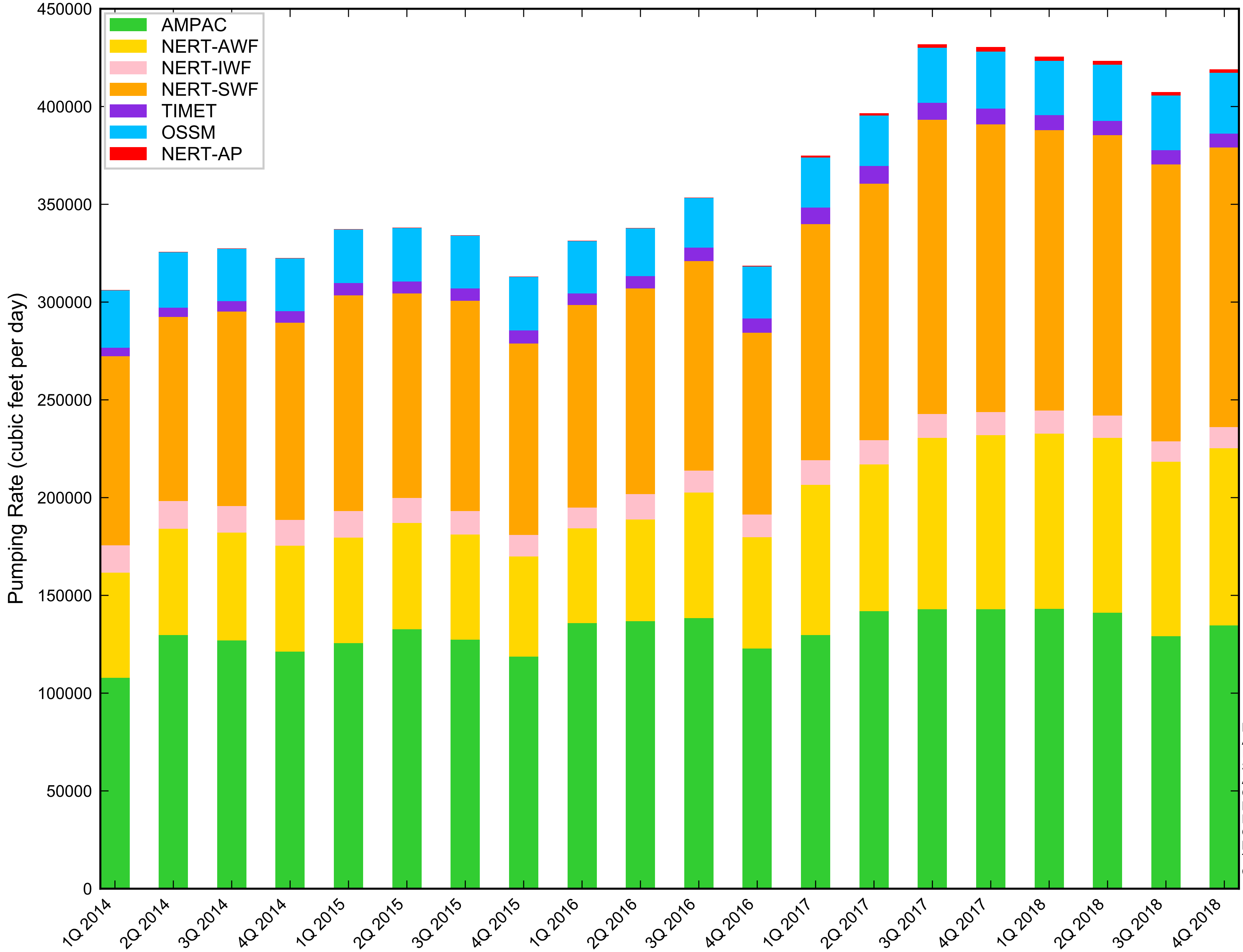
RAMBOLL

Groundwater Level versus Stream Stage
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-10

Drafter: PR | Date: 10/31/19 | Contract Number: 1690011200-034 | Approved: | Revised:

H:\LePetomane\NERT\Modeling\Phase 6 Model\Model Post Processing\Head Calibration Plots\combined_pumping_rate.py



Note:
AWF = Athens Well Field
IWF = Interceptor Well Field
SWF = Seep Well Field
AMPAC = American Pacific Corporation, now Endeavour LLC
NERT = Nevada Environmental Response Trust
OSSM = Olin/Stauffer/Syngenta/Montrose
TIMET = Titanium Metals Corporation

RAMBOLL

Remediation Pumping in the Model Domain (2014-2018)
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-11

Drafter: CT | Date: 10/28/19 | Contract Number: 1690011200-034 | Approved: | Revised:

EXPLANATION

- Mining
- Municipal
- Industrial
- Commercial
- Phase 6 Model Extent
- Off-Site NERT RI Study Area
- NERT Property Boundary

Note:
* Industrial well location is approximated using the center of its listed section.

gpm = gallons per minute

N

0 0.5 1 Miles

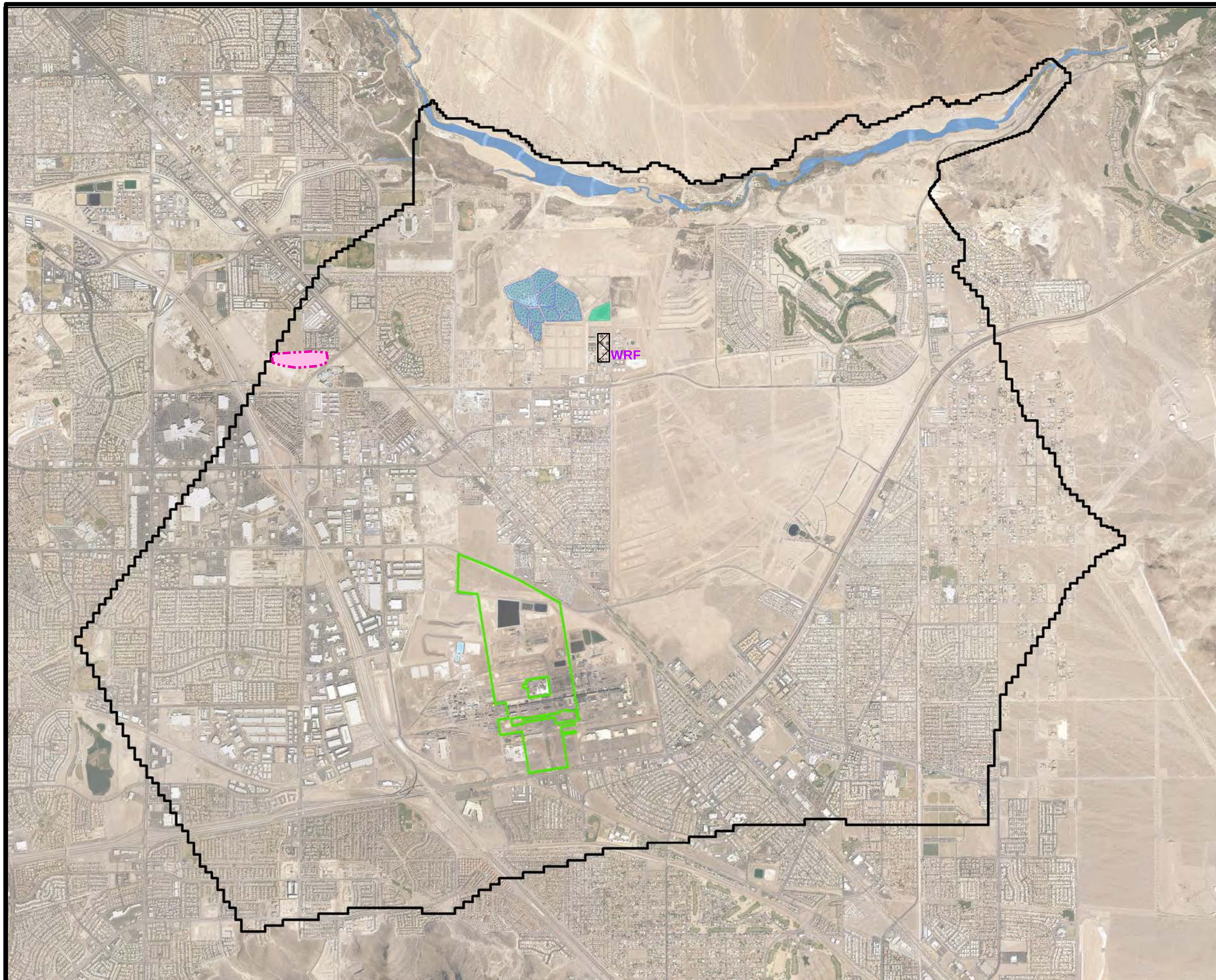
RAMBOLL

NON-REMEDIATION PUMPING IN THE MODEL DOMAIN

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: AR	Approved:	Revised:	3-12

Path: H:\LePetomane\NERTModeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 3-12 - Non-Remediation Pumping in Model Domain.mxd



EXPLANATION

- Phase 6 Model Extent
- NERT Property Boundary
- Bird Viewing Preserve, unlined
- Pond 13, unlined
- Las Vegas Wash
- Gravel Pit Pond

Notes:

WRF = Water Reclamation Facility

N

0 0.5 1 Miles

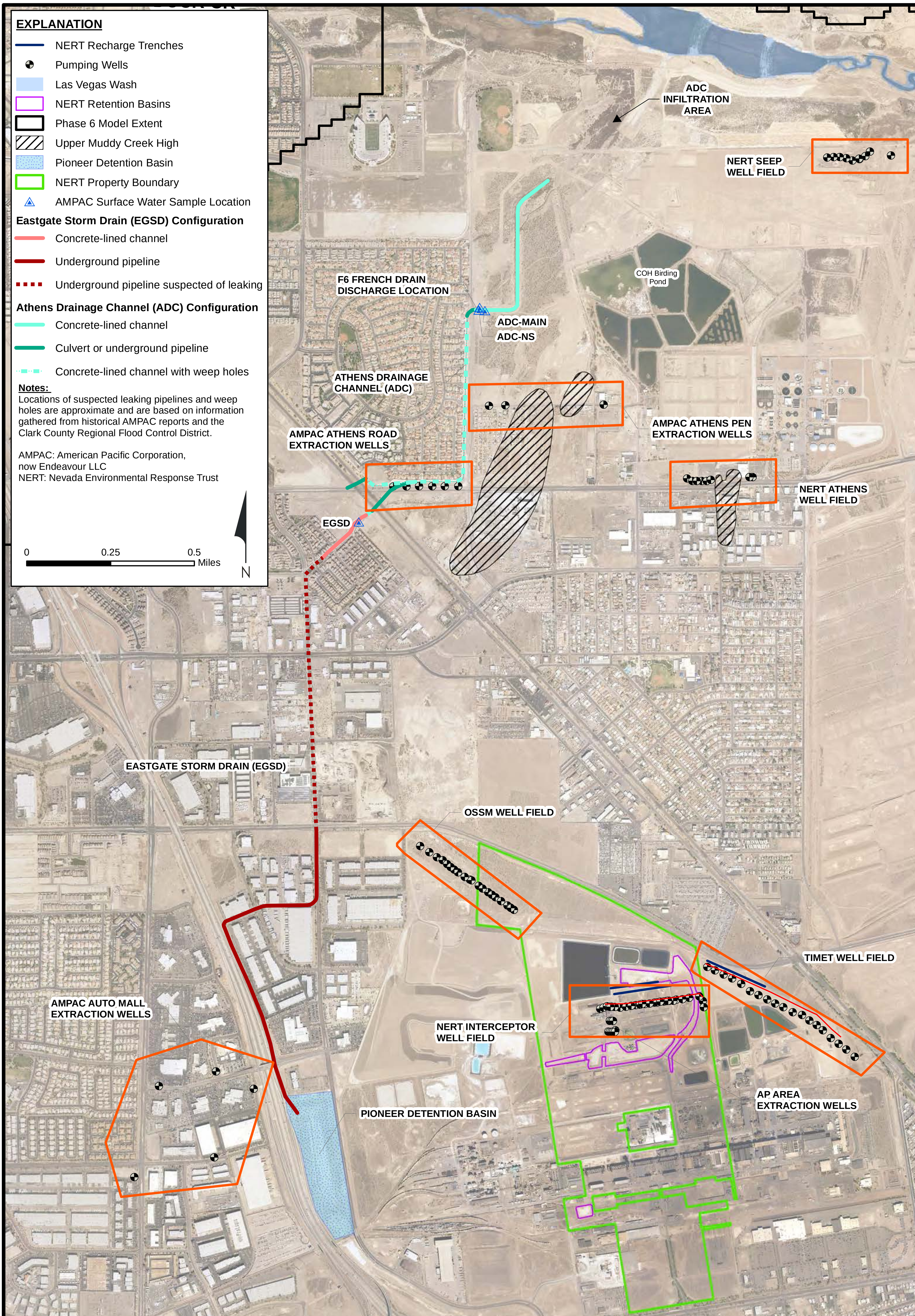
RAMBOLL

MODEL AREA FEATURES: UNLINED PONDS

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: AS	Approved:	Revised:	3-13

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 3-13 - Model Area Features - Unlined Ponds.mxd

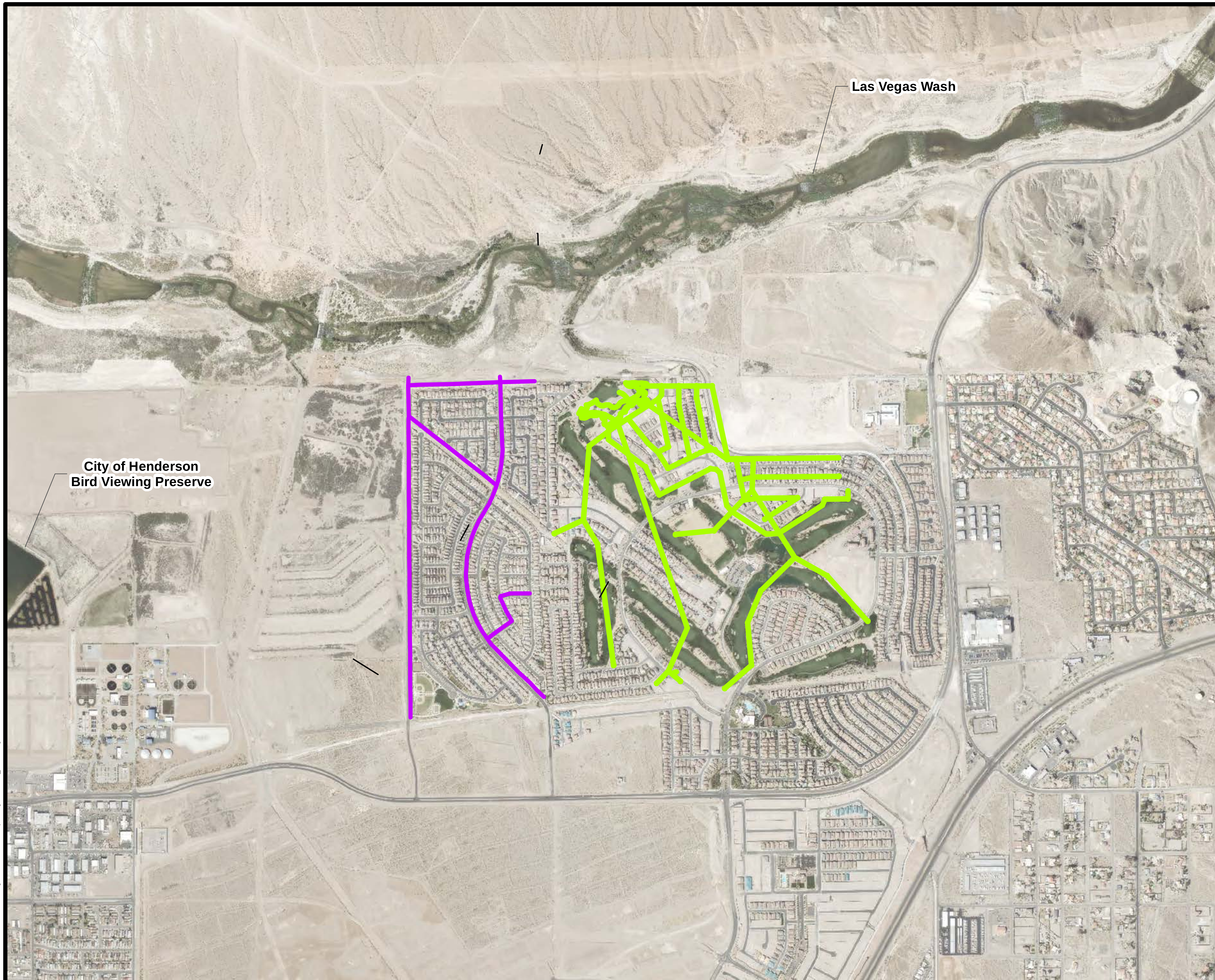


RAMBOLL

DRAFTED BY: KL | DATE: 11/1/2019

MODEL AREA FEATURES: STORM DRAINS
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
3-14
1690011200-034



EXPLANATION

Weston Hills Sub-Drains

Golf Course Sub-Drains

N

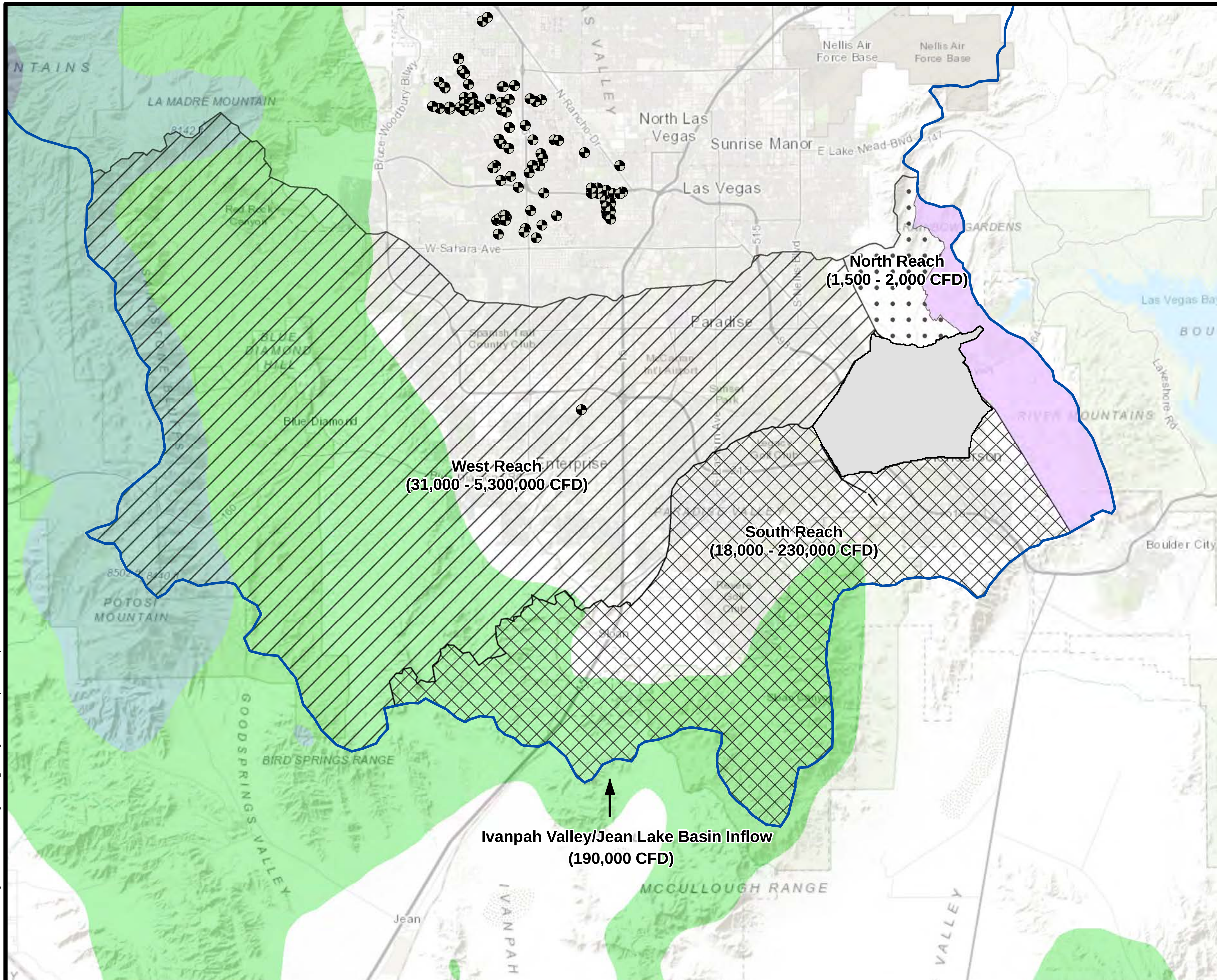
0 0.25 0.5 Miles

RAMBOLL

MODEL AREA FEATURES:
SUB-DRAINS
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: AS	Approved:	Revised:	3-15

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 3-15 - Golf Course Sub-Drains.mxd



EXPLANATION

- LVVWD Pumping Wells
- Las Vegas Valley Hydrologic Basin
- Phase 6 Model Extent
- Volcanic and Conglomerate Rocks
- North Reach
- West Reach
- South Reach

Recharge Rate (in/yr)

- 0.0005 - 0.05
- 0.05 - 0.5
- 0.5 - 5
- > 5

Notes:

in/yr = inches per year
CFD = cubic feet per day
LVVWD = Las Vegas Valley Water District

N

0 2.5 5 Miles

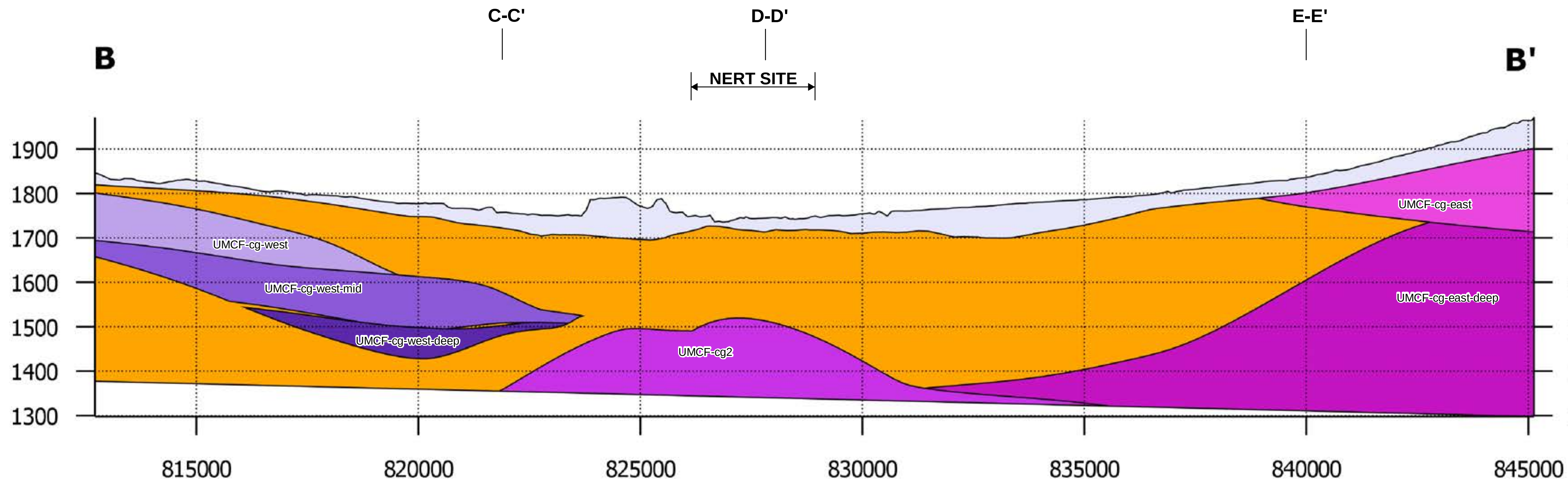
RAMBOLL

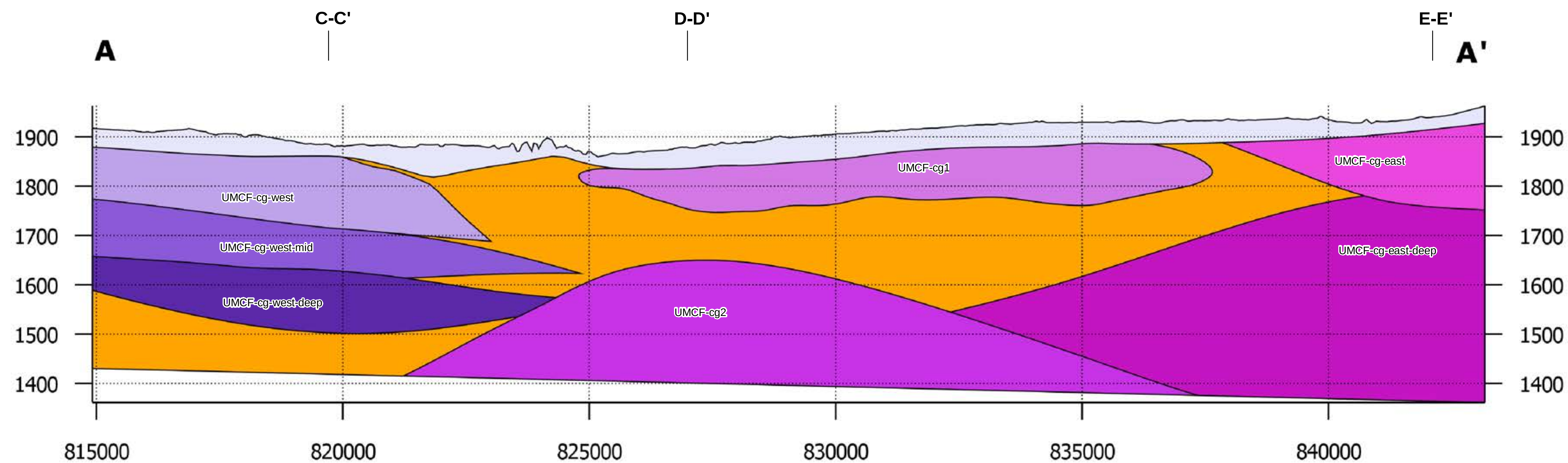
CONCEPTUAL BOUNDARY INFLOWS

Nevada Environmental Response Trust Site
Henderson, Nevada

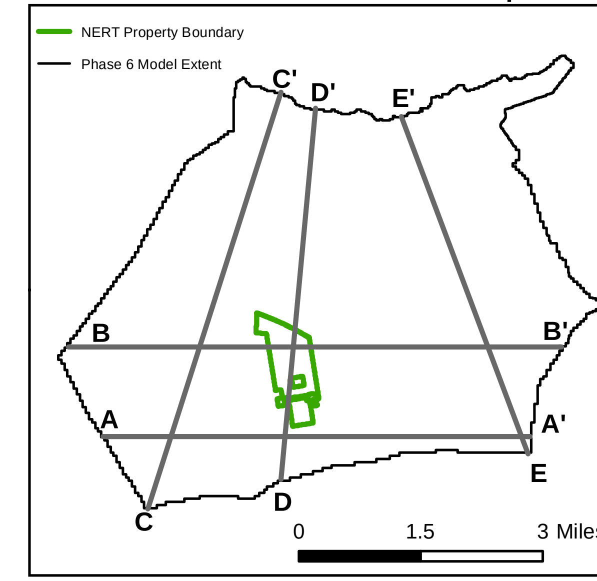
Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: AS	Approved:	Revised:	3-16

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 3-16 - Conceptual Boundary Inflows.mxd





Cross Section Location Map



EXPLANATION

- Alluvium
- UMCF-cg1
- UMCF-cg2
- UMCF-cg-west
- UMCF-cg-west-mid
- UMCF-cg-west-deep
- UMCF-cg-east
- UMCF-cg-east-deep
- UMCF-fg

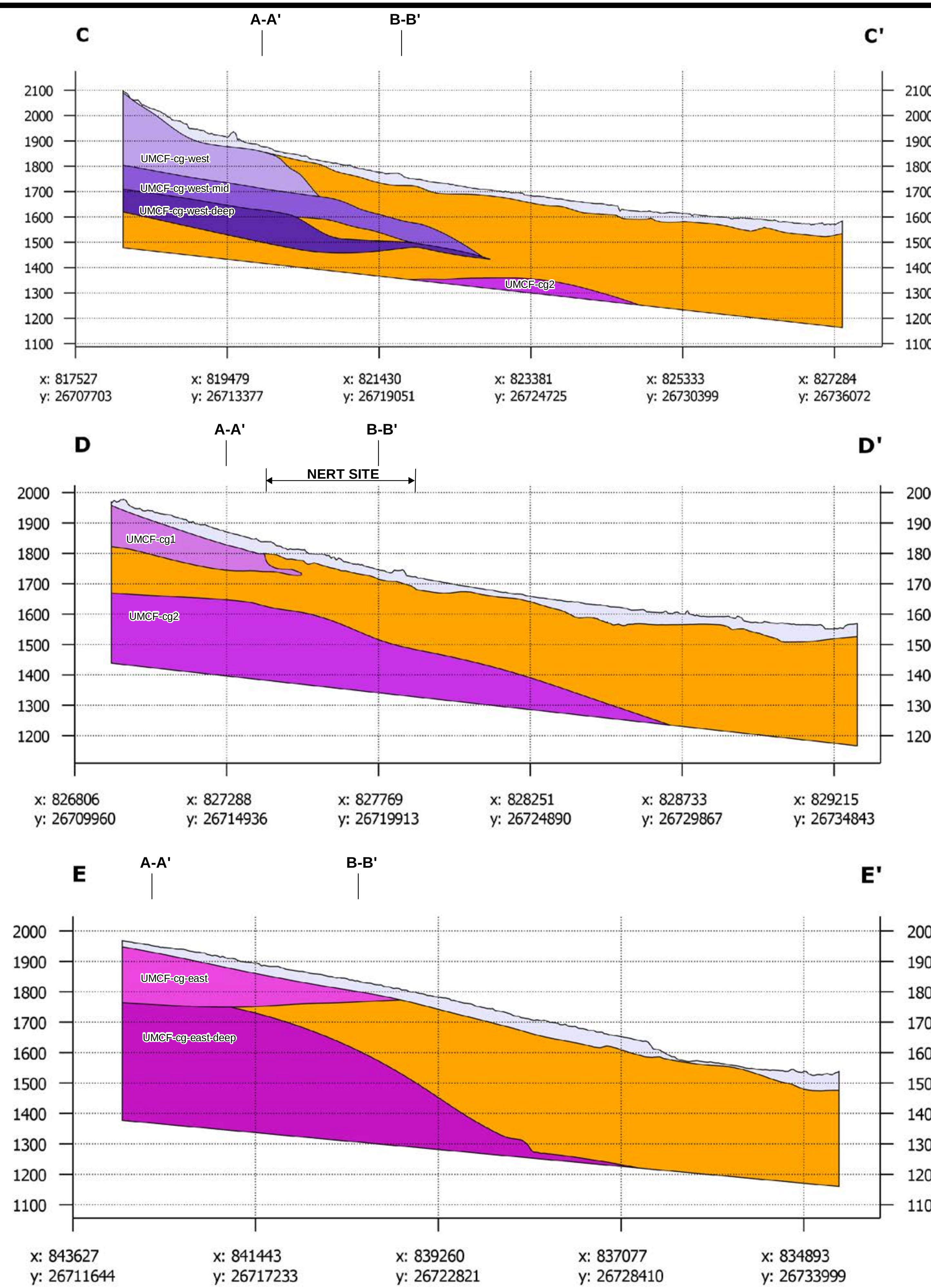
Note: Cross sections are not drawn at the same scale.
Elevations are in feet above mean sea level.
XY coordinates are in Nevada State Plane East (feet).

NERT = Nevada Environmental Response Trust Site
UMCF-fg = Fine-grained Upper Muddy Creek Formation
UMCF-cg = Coarse-grained Upper Muddy Creek Formation

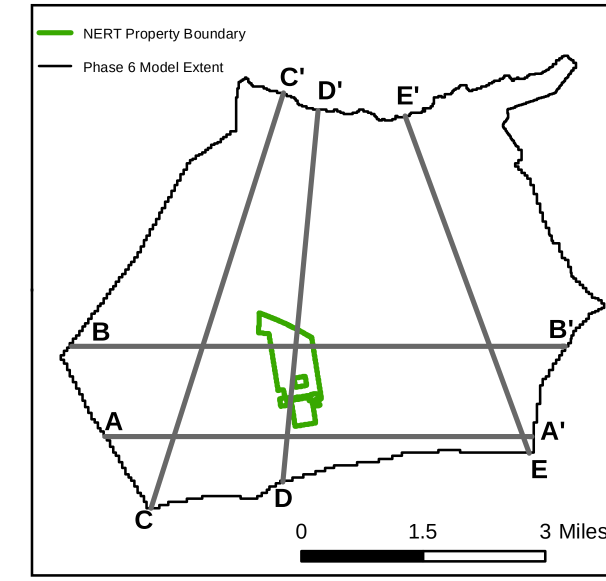
E-W GEOLOGICAL MODEL CROSS SECTIONS
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/25/2019	Contract Number: 1690011200-034		Figure
Drafter: LAT	Approved:	Revised:	**4-1**

\\wcevlfps1\ENG\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 4-1 - E-W Geological Model XSects.mxd



Cross Section Location Map



EXPLANATION

- Alluvium
- UMCF-cg1
- UMCF-cg2
- UMCF-cg-west
- UMCF-cg-west-mid
- UMCF-cg-west-deep
- UMCF-cg-east
- UMCF-cg-east-deep
- UMCF-fg

Note: Cross sections are not drawn at the same scale.
Elevations are in feet above mean sea level.
XY coordinates are in Nevada State Plane East (feet).

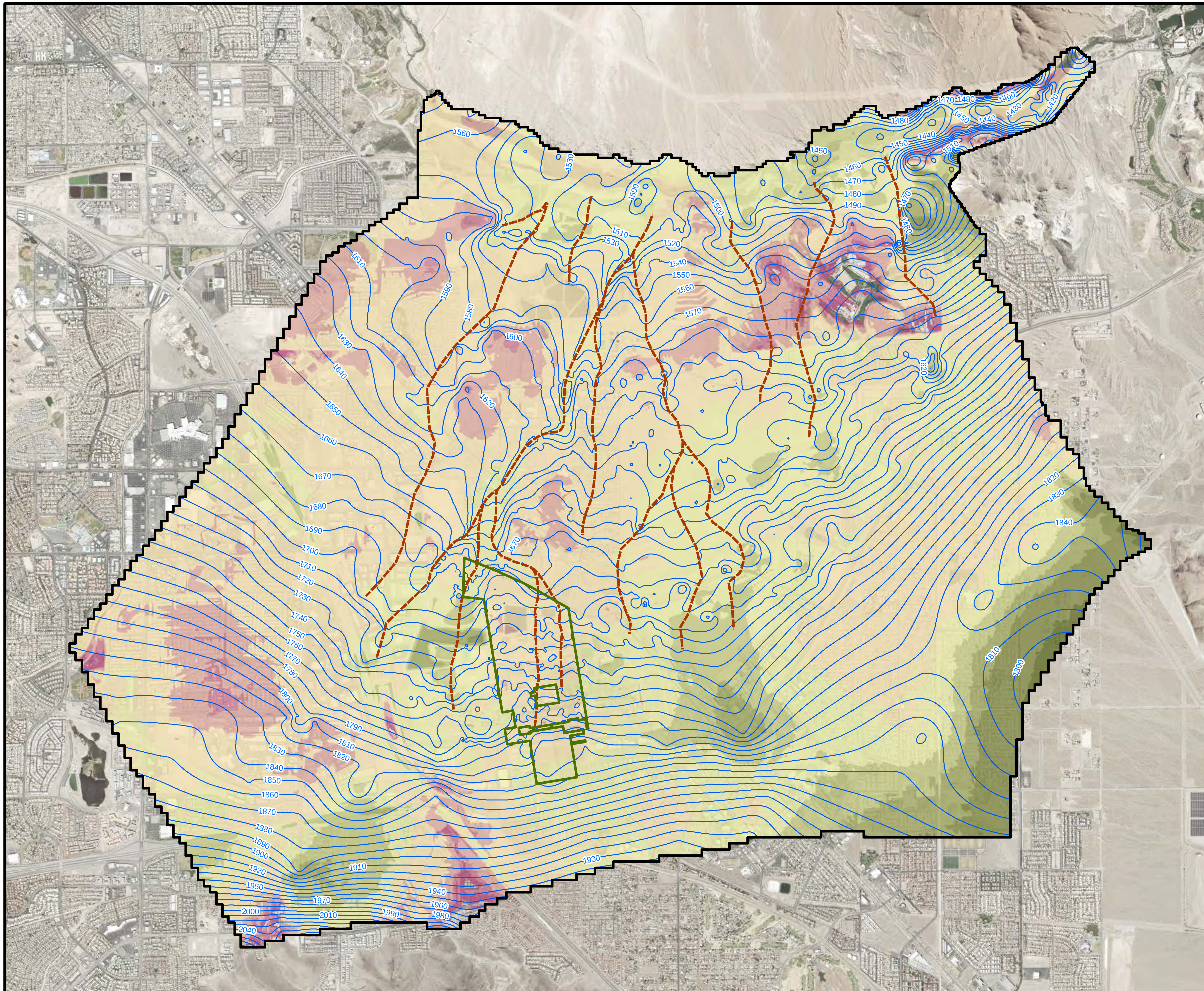
NERT = Nevada Environmental Response Trust Site
UMCF-fg = Fine-grained Upper Muddy Creek Formation
UMCF-cg = Coarse-grained Upper Muddy Creek Formation

RAMBOLL

N-S GEOLOGICAL MODEL CROSS SECTIONS
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/25/2019	Contract Number: 1690011200-034		Figure
Drafter: LAT	Approved:	Revised:	4-2

\\wcevfps1\ENG\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 4-2 - N-S Geological Model XSects.mxd



EXPLANATION

- Phase 6 Model Extent
- NERT Property Boundary
- Alluvium-Upper Muddy Creek Formation Contact Elevation (feet above mean sea level)
- Paleochannels

Alluvium Thickness (feet)

- 0 - 0.1
- 0.1-5
- 5-10
- 10-20
- 20-40
- 40-60
- 60-80
- 80-100
- 100-150
- >150

N

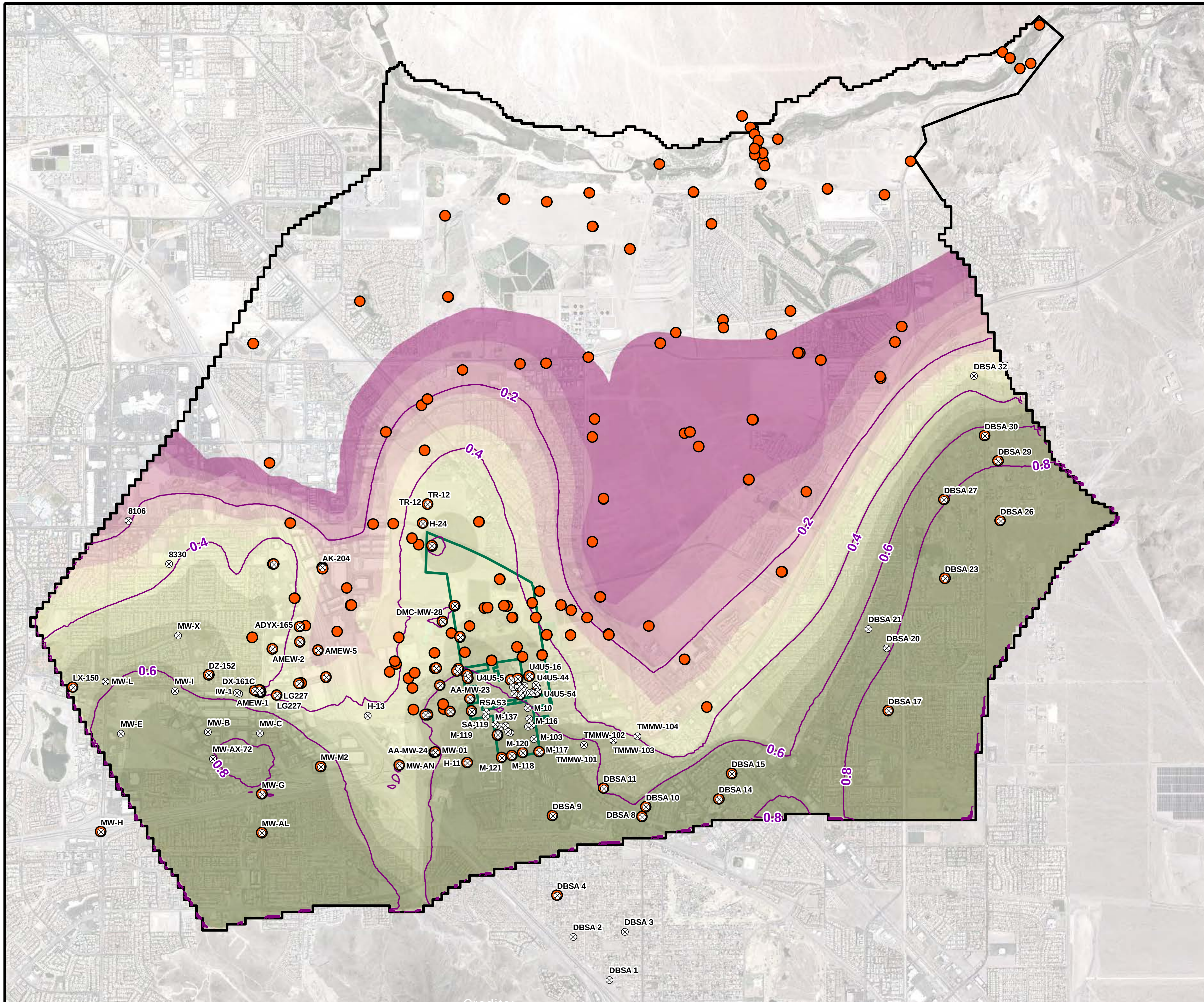
0 0.5 1 Miles

RAMBOLL

ALLUVIUM THICKNESS
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 4-3
Drafter: AS	Approved:	Revised:	

H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 4-3 - Qal UMCf Contact Elevation.mxd



EXPLANATION

Phase 6 Model Extent

NERT Property Boundary

Borehole Intersecting UMCf-cg

Borehole Data Below 100 feet

Fraction Coarse-Grained [a]

UMCf-cg Thickness (feet)

0 - 30

30 - 50

50 - 80

80 - 110

110 - 140

140 - 180

180 - 220

220 - 260

260 - 300

>300

Note:
[a] Ratio of thickness of UMCf-cg to total UMCf within the vertical extent of the model.

UMCf = Upper Muddy Creek Formation
UMCf-cg = Coarse-grained UMCf

N

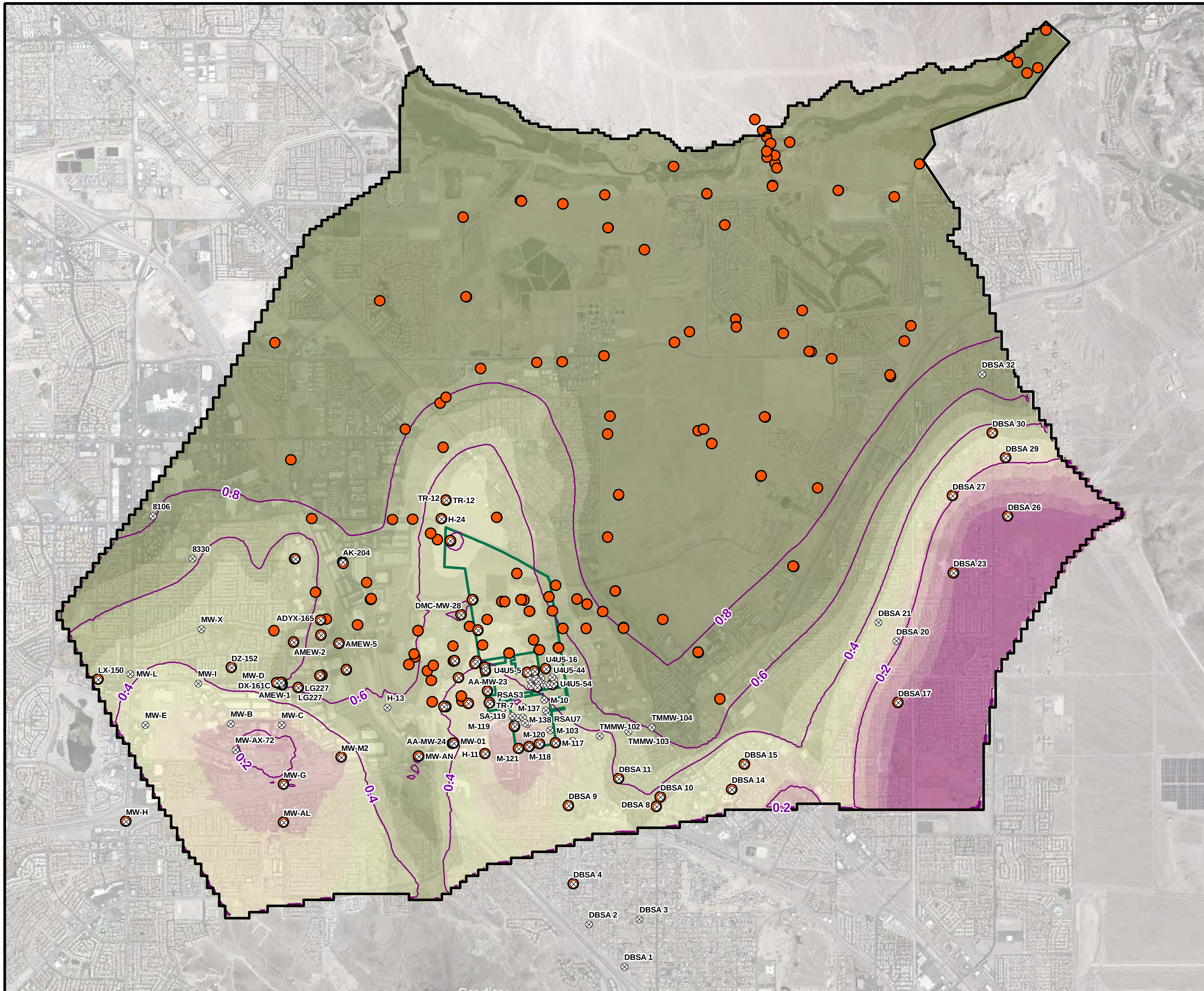
0 0.5 1 Mile

RAMBOLL

COARSE-GRAINED UPPER MUDDY CREEK FORMATION THICKNESS
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 4-4
Drafter: LAT/MS	Approved:	Revised:	

H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 4-4 - UMCfcg_elev_thickness11x17.mxd



EXPLANATION

- Phase 6 Model Extent
- NERT Property Boundary
- Borehole Intersecting UMCf-fg and cg
- Borehole Data Below 100 feet
- Fraction Fine-Grained [a]

UMCf-fg Thickness (feet)

- 0 - 30
- 30 - 50
- 50 - 80
- 80 - 110
- 110 - 140
- 140 - 180
- 180 - 220
- 220 - 260
- 260 - 300
- >300

[a] Ratio of thickness of UMCf-fg to total UMCf within the vertical extent of the model.

UMCf = Upper Muddy Creek Formation
UMCf-fg = Fine-grained UMCf
UMCf-cg = Coarse-grained UMCf

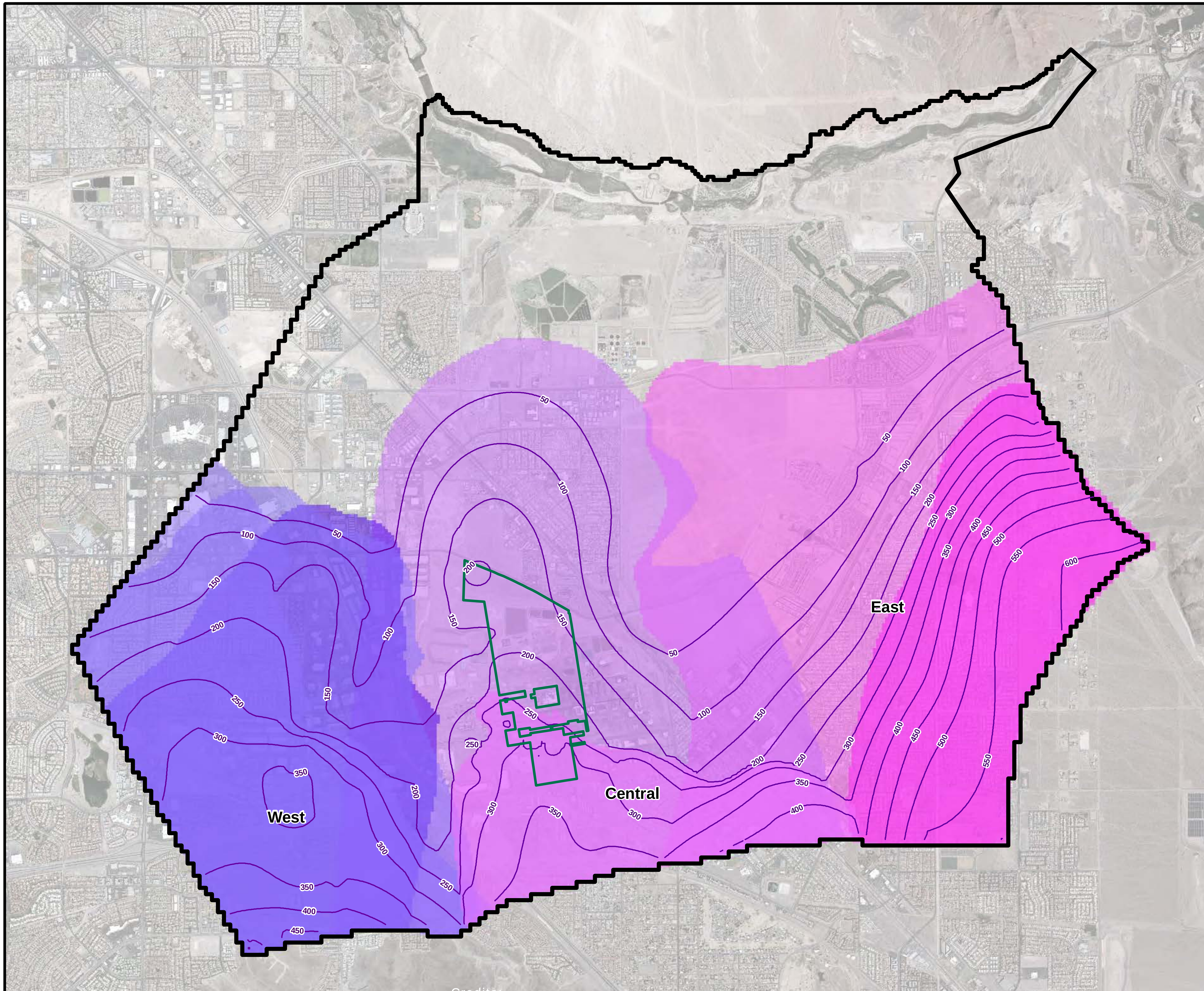
RAMBOLL

FINE-GRAINED UPPER MUDDY CREEK FORMATION THICKNESS

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/18/2019	Contract Number: 1690011200-034		Figure
Drafter: LAT/MS	Approved:	Revised:	4-5

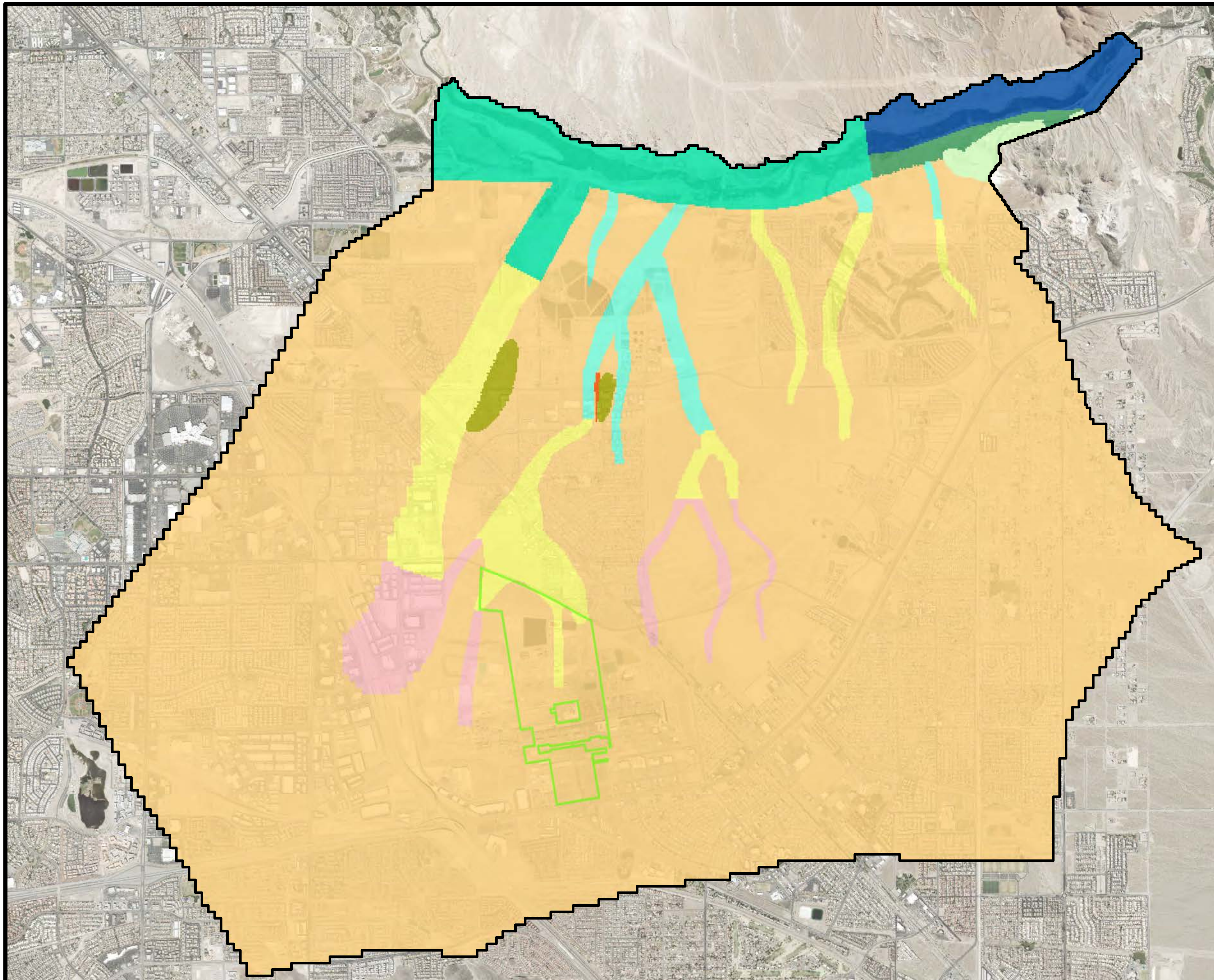
\\wcevlfps1\ENG\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 4-5 -UMCf_fg_elev_thickness11x17.mxd



RAMBOLL

COARSE-GRAINED UPPER MUDDY CREEK FORMATION DEPOSITIONAL SERIES
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 4-6
Drafter: LAT/MS	Approved:	Revised:	



EXPLANATION

Phase 6 Model Extent

NERT Property Boundary

Hydraulic Conductivity (ft/d)

Value	Unit
0.66	Horse Spring Formation
1.7	UMCf-fg
21	Alluvium
45	Alluvium
100	Paleochannels and Wash Gravels
175	Paleochannels and Wash Gravels
200	Paleochannels and Wash Gravels
300	Paleochannels and Wash Gravels
550	Paleochannels and Wash Gravels
700	Paleochannels and Wash Gravels

Note: Horizontal hydraulic conductivity values shown are in feet per day.

UMCf-fg = Fine-grained Upper Muddy Creek Formation

N

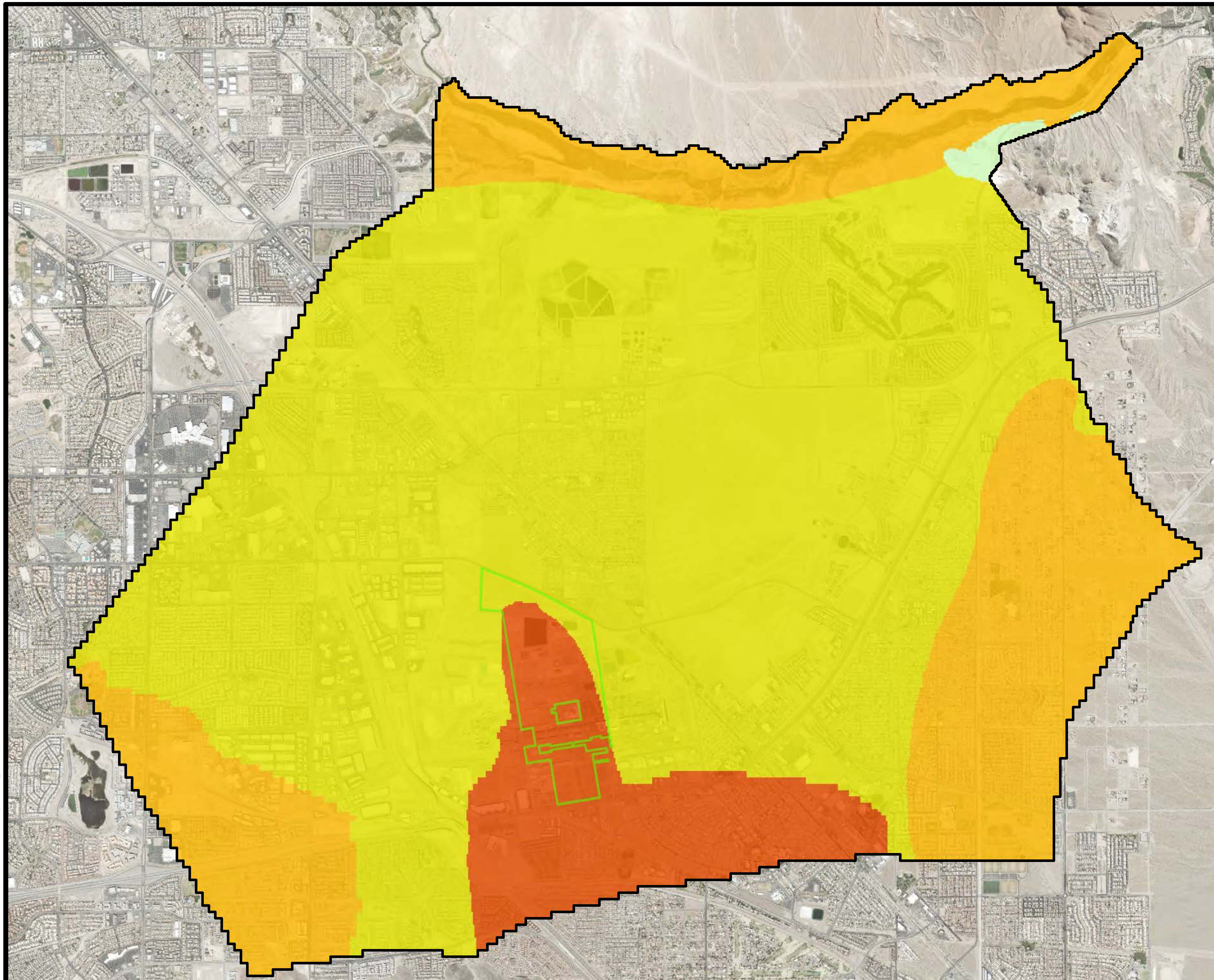
0 0.5 1 Miles

RAMBOLL

Model Hydraulic Conductivity in Layer 1
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: RZ	Approved:	Revised:	5-1

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-1 - Model Hydraulic Conductivity in Layer 1.mxd



EXPLANATION

Phase 6 Model Extent
NERT Property Boundary

Hydraulic Conductivity (ft/d)

0.66 — Horse Spring Formation
6 — xMCf
10 — xMCf/ UMCf-cg
30 — UMCf-cg

Note: Horizontal hydraulic conductivity values shown are in feet per day.

UMCf-cg = Coarse-grained Upper Muddy Creek Formation
xMCf = Transitional Muddy Creek Formation

N

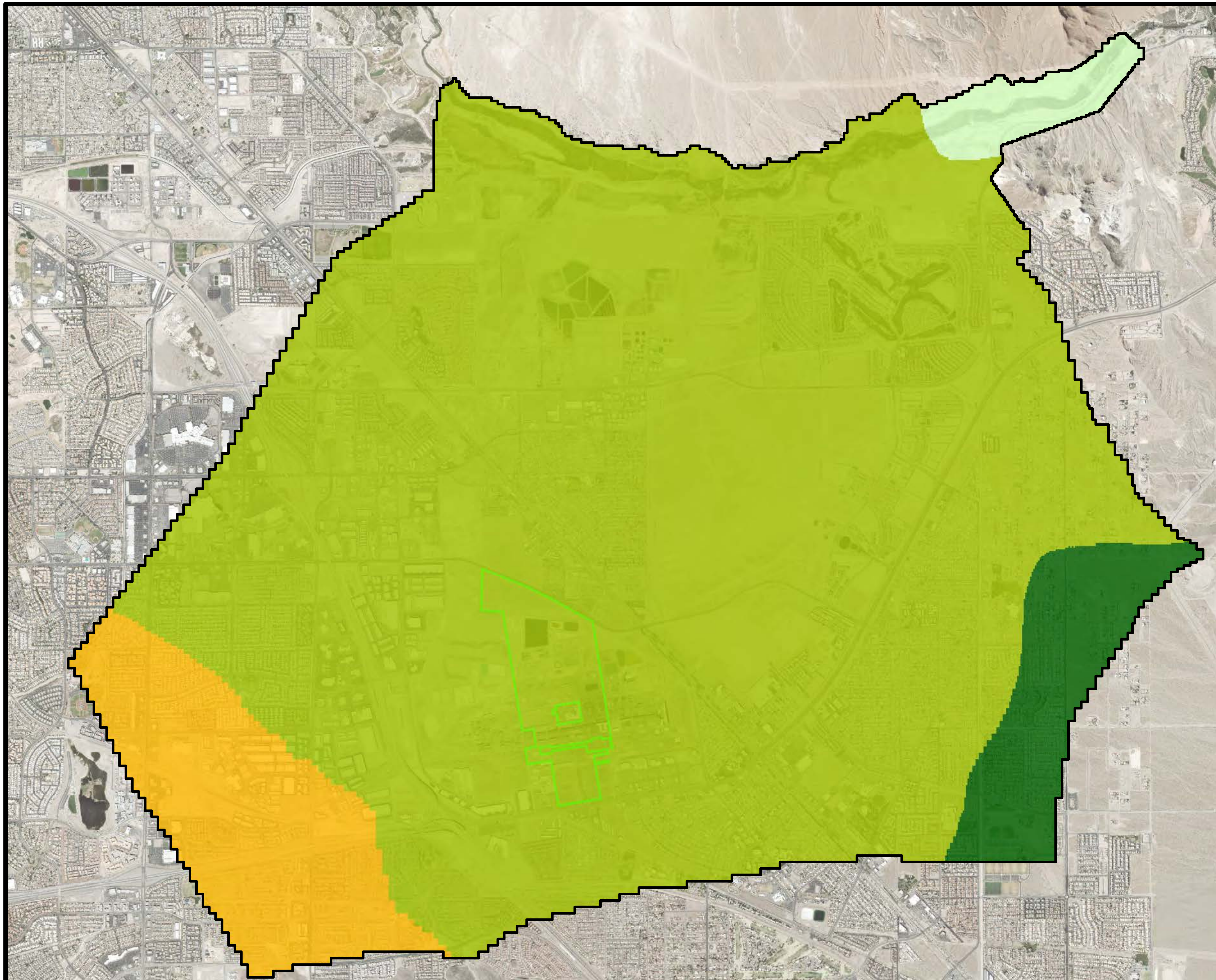
0 0.5 1 Miles

RAMBOLL

Model Hydraulic Conductivity in Layer 2
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: RZ	Approved:	Revised:	5-2

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-2 - Model Hydraulic Conductivity in Layer 2.mxd



EXPLANATION

Phase 6 Model Extent

NERT Property Boundary

Hydraulic Conductivity (ft/d)

0.66 — Horse Spring Formation

0.72 — UMCf-fg

1 } UMCf-cg

10

Note: Horizontal hydraulic conductivity values shown are in feet per day.

UMCf-fg = Fine-grained Upper Muddy Creek Formation
UMCf-cg = Coarse-grained Upper Muddy Creek Formation

N

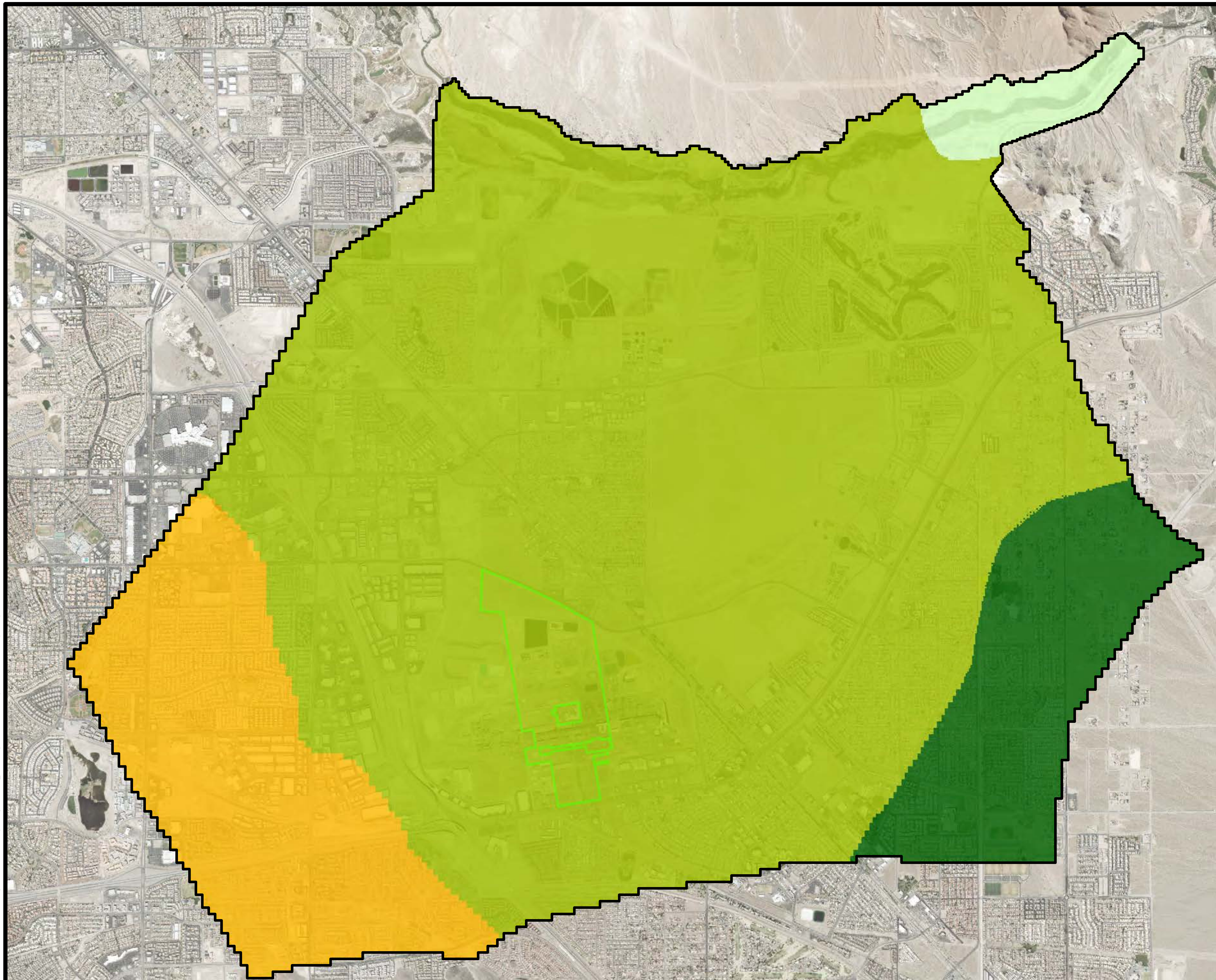
0 0.5 1 Miles

RAMBOLL

Model Hydraulic Conductivity in Layer 3
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: RZ	Approved:	Revised:	5-3

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-3 - Model Hydraulic Conductivity in Layer 3.mxd



EXPLANATION

- Phase 6 Model Extent
- NERT Property Boundary

Hydraulic Conductivity (ft/d)

- 0.66 — Horse Spring Formation
- 0.72 — UMCf-fg
- 1 } UMCf-cg
- 10 } UMCf-cg

Note: Horizontal hydraulic conductivity values shown are in feet per day.

UMCf-fg = Fine-grained Upper Muddy Creek Formation
UMCf-cg = Coarse-grained Upper Muddy Creek Formation

N

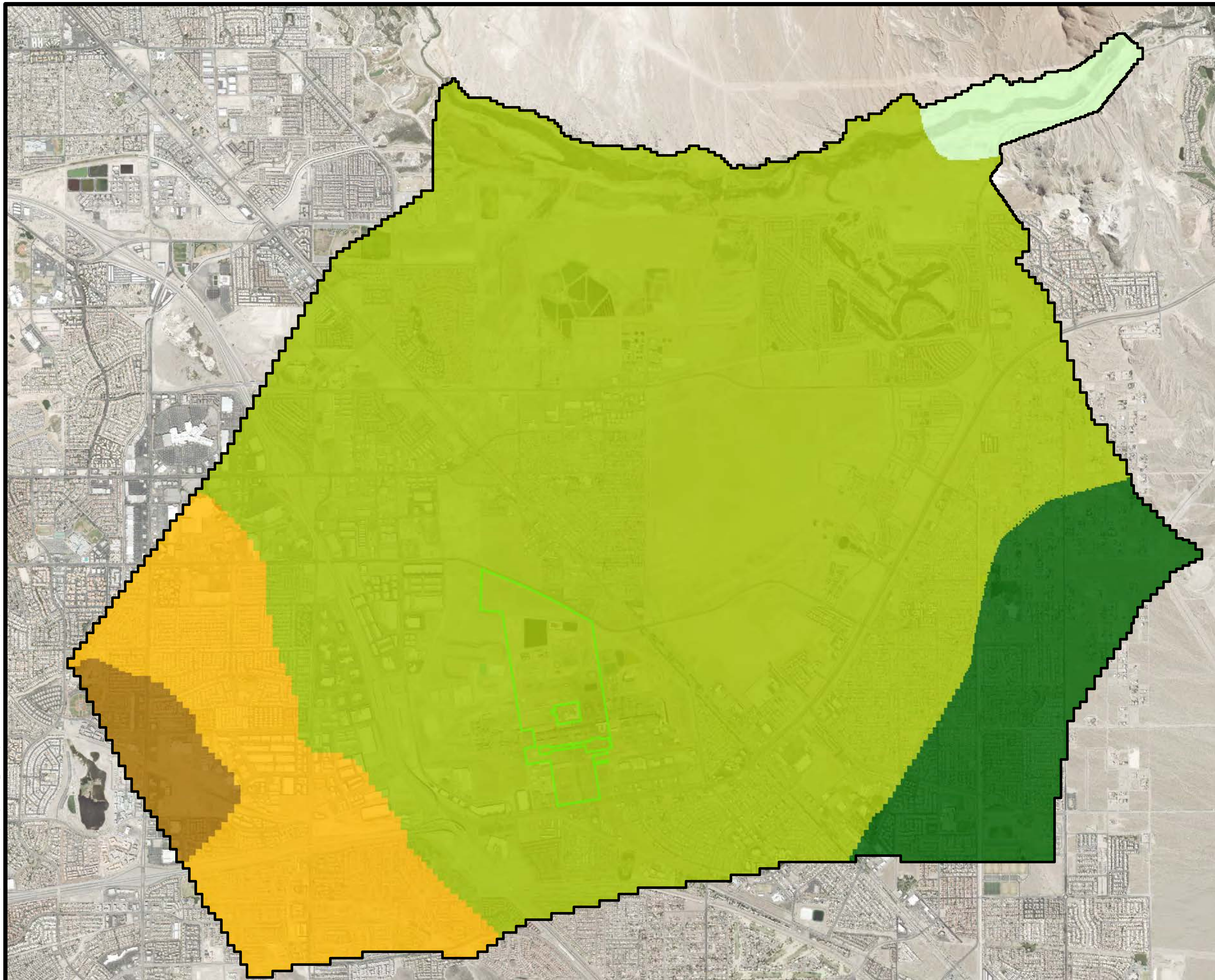
0 0.5 1 Miles

RAMBOLL

Model Hydraulic Conductivity in Layer 4 to 5
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: RZ	Approved:	Revised:	5-4

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-4 - Model Hydraulic Conductivity in Layer 4 to 5.mxd



EXPLANATION

Phase 6 Model Extent

NERT Property Boundary

Hydraulic Conductivity (ft/d)

0.66 — Horse Spring Formation

0.72 — UMCf-fg

1

1.2 } UMCf-cg

10

Note: Horizontal hydraulic conductivity values shown are in feet per day.

UMCf-fg = Fine-grained Upper Muddy Creek Formation
UMCf-cg = Coarse-grained Upper Muddy Creek Formation

N

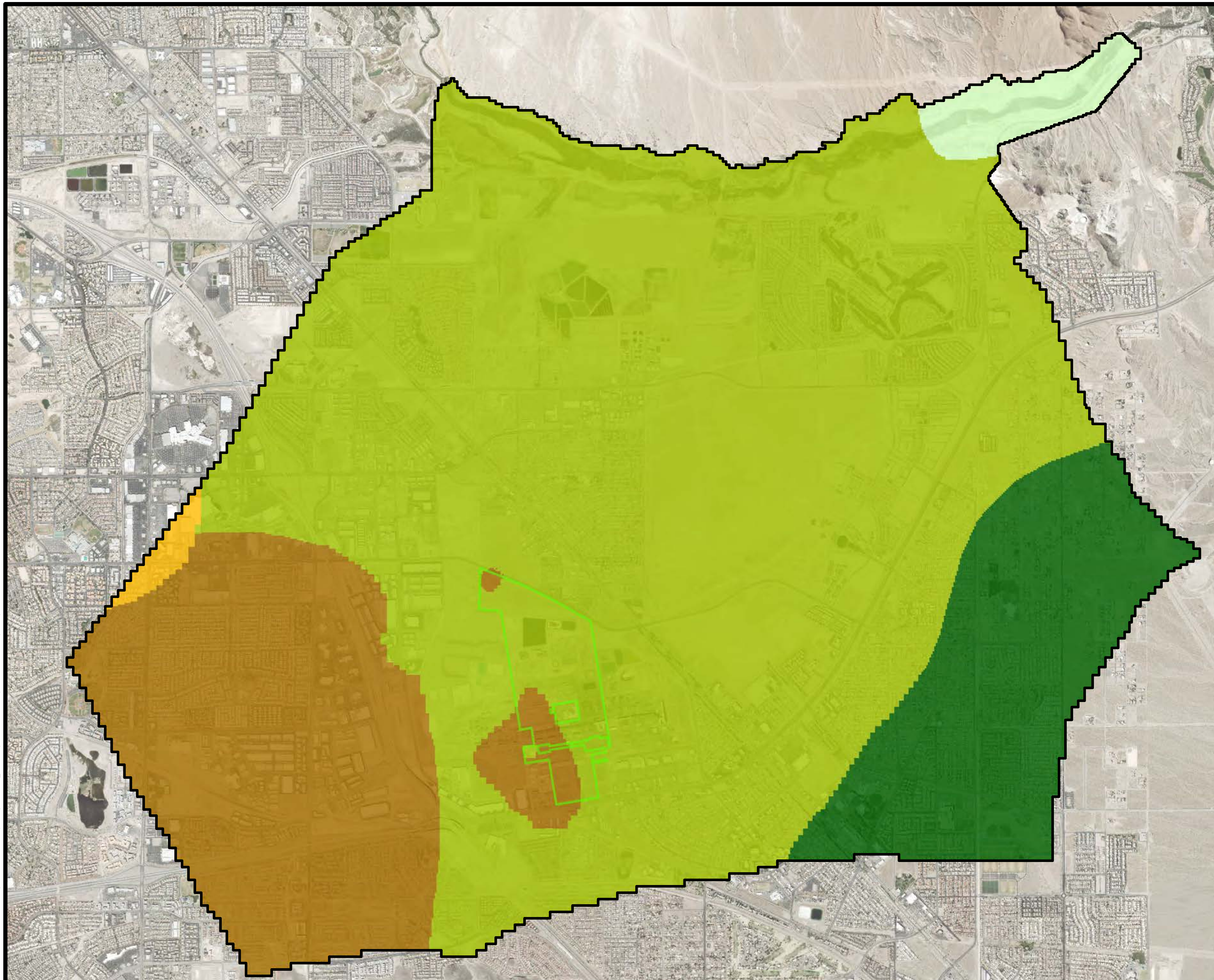
0 0.5 1 Miles

RAMBOLL

Model Hydraulic Conductivity in Layer 6 to 7
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: RZ	Approved:	Revised:	5-5

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-5 - Model Hydraulic Conductivity in Layer 6 to 7.mxd



EXPLANATION

Phase 6 Model Extent

NERT Property Boundary

Hydraulic Conductivity (ft/d)

0.66 — Horse Spring Formation

0.72 — UMCf-fg

1 }
1.2 } UMCf-cg
10 }

Note: Horizontal hydraulic conductivity values shown are in feet per day.

UMCf-fg = Fine-grained Upper Muddy Creek Formation
UMCf-cg = Coarse-grained Upper Muddy Creek Formation

N

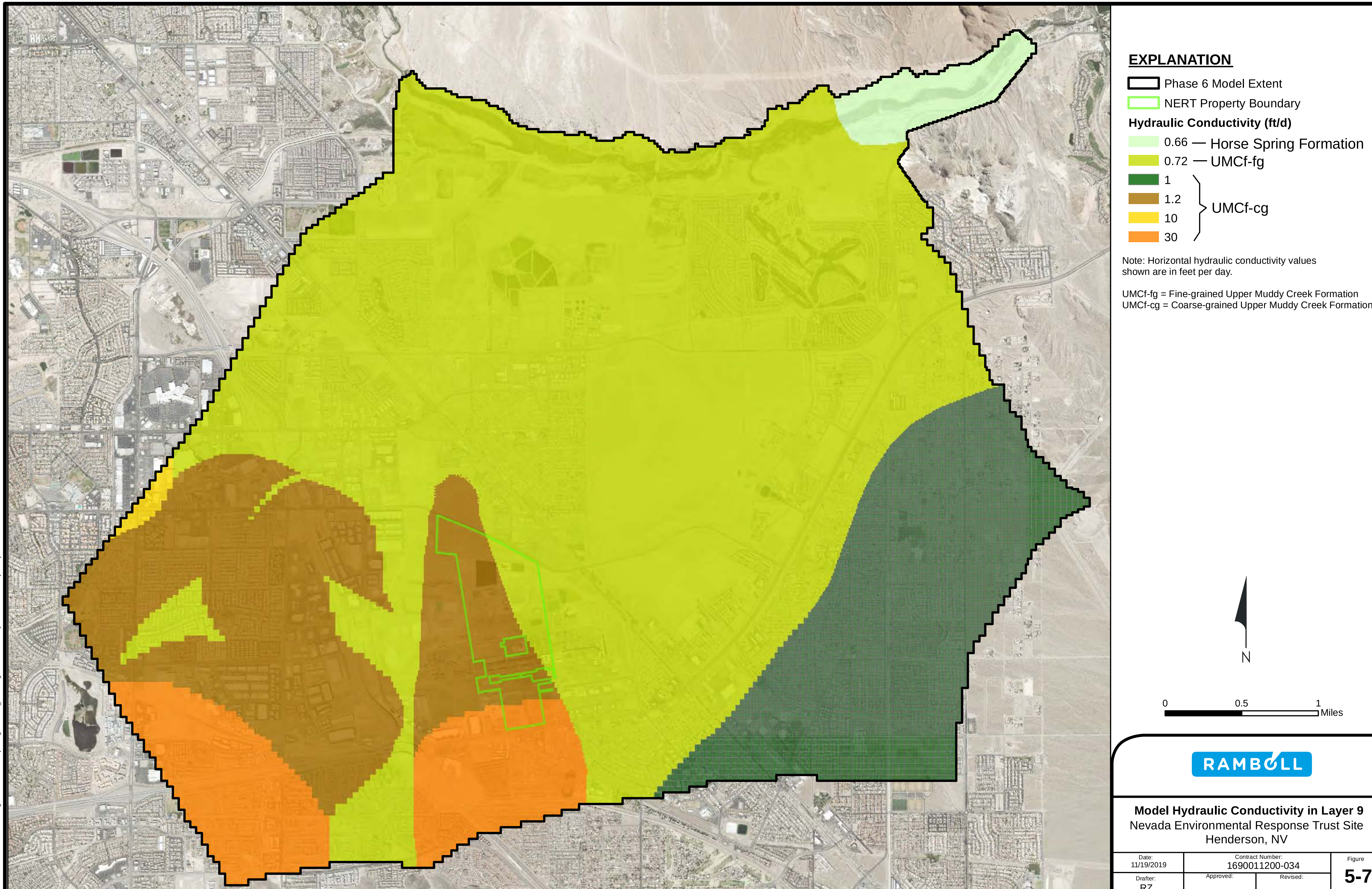
0 0.5 1 Miles

RAMBOLL

Model Hydraulic Conductivity in Layer 8
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: RZ	Approved:	Revised:	5-6

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-6 - Model Hydraulic Conductivity in Layer 8.mxd

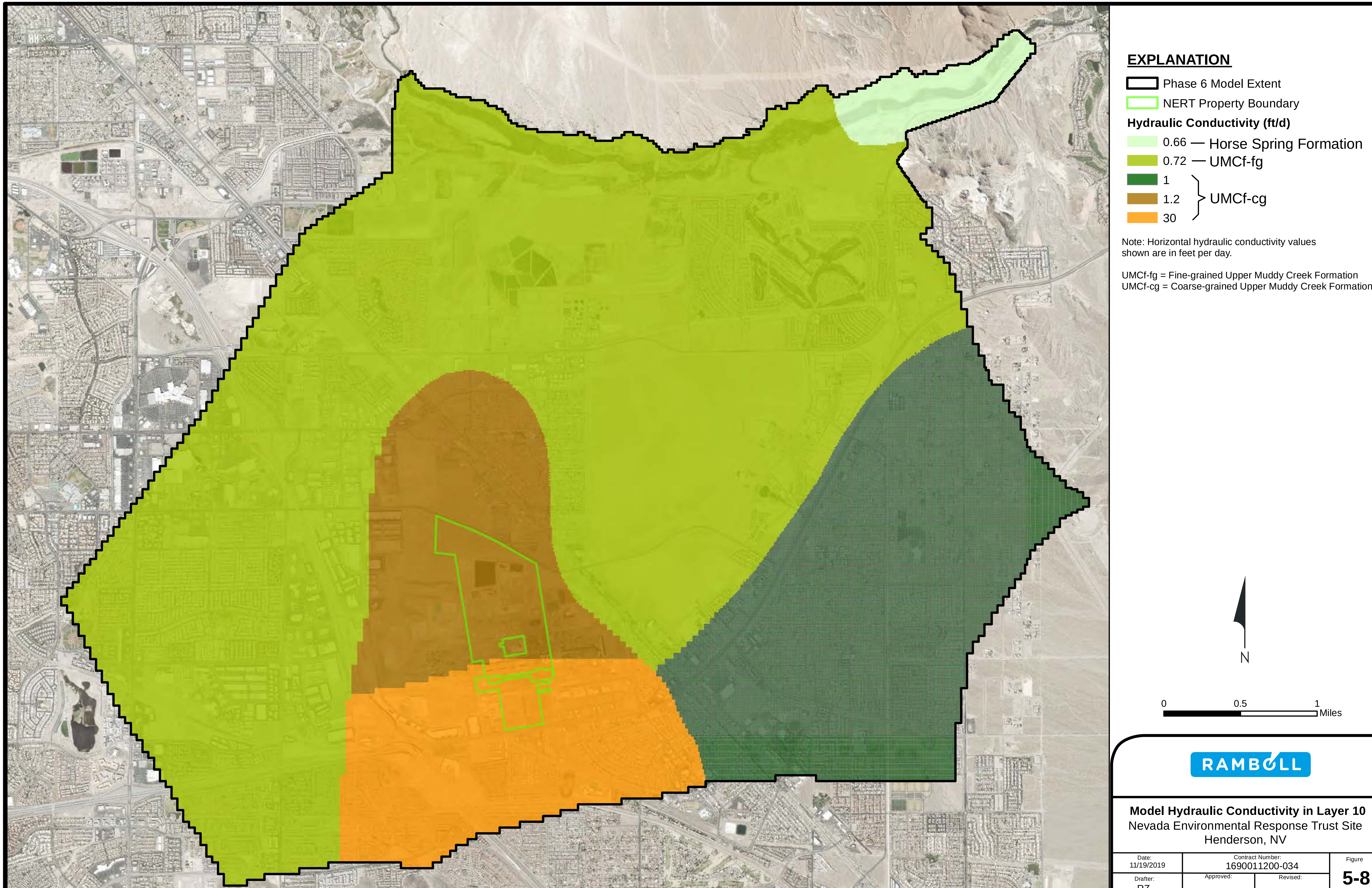


RAMBOLL

Model Hydraulic Conductivity in Layer 9
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: RZ	Approved:	Revised:	5-7

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-7 - Model Hydraulic Conductivity in Layer 9.mxd

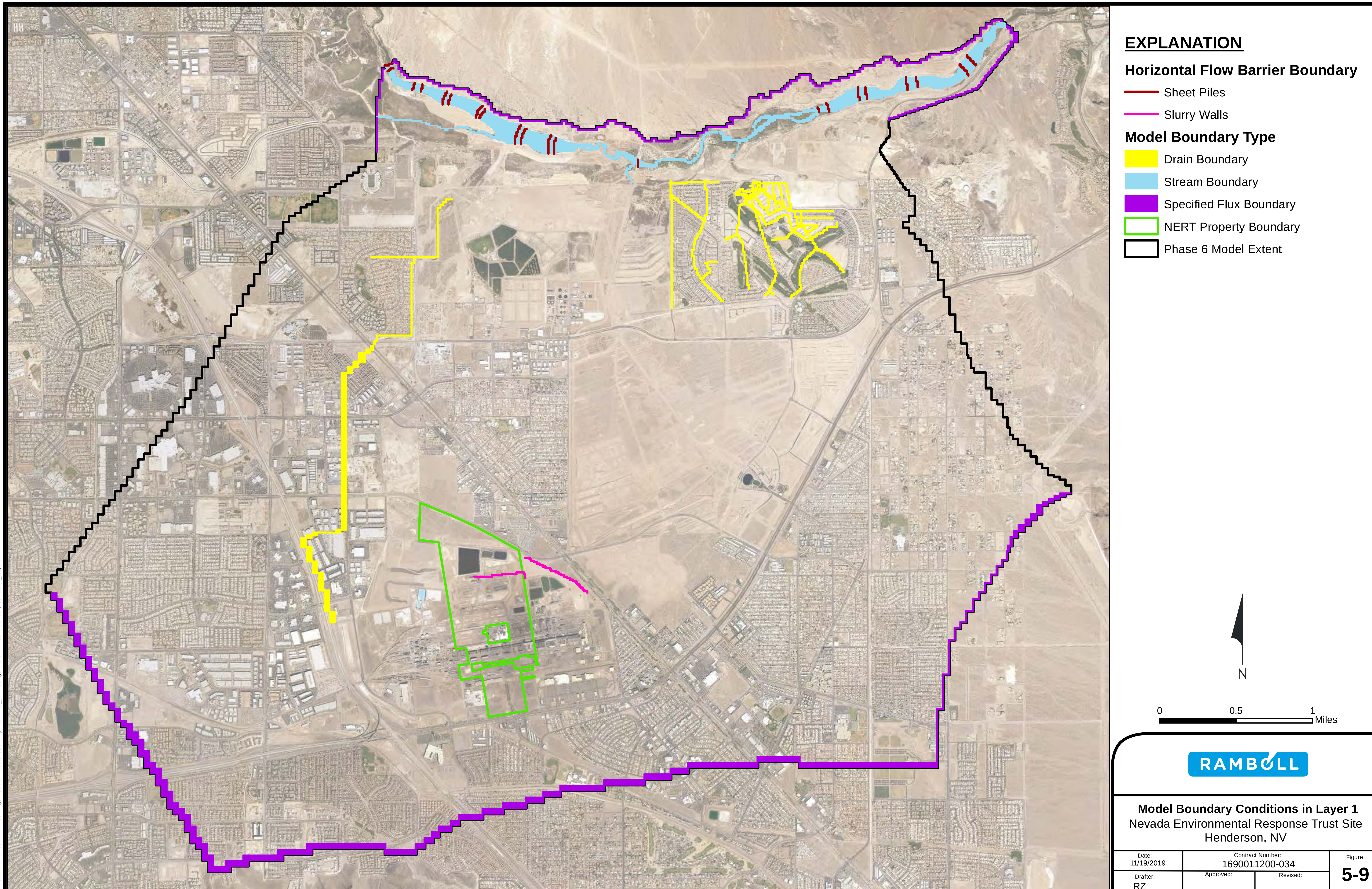


RAMBOLL

Model Hydraulic Conductivity in Layer 10
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: RZ	Approved:	Revised:	5-8

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-8 - Model Hydraulic Conductivity in Layer 10.mxd

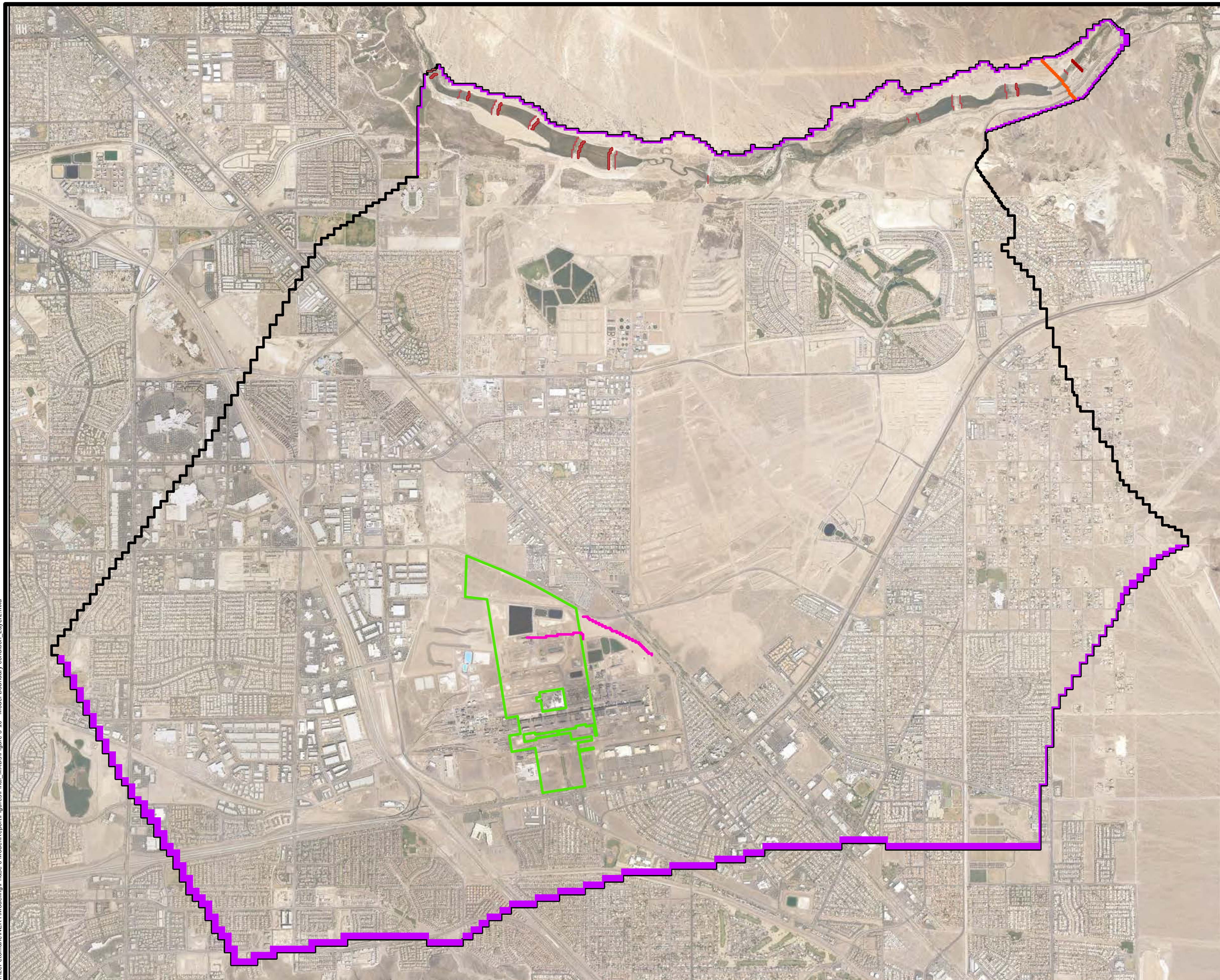


RAMBOLL

Model Boundary Conditions in Layer 1
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 5-9
Drafter: RZ	Approved:	Revised:	

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-9 - Model Boundary condition_Layer1.mxd



EXPLANATION

Horizontal Flow Barrier Boundary

- Sheet Piles
- Slurry Walls
- Frenchman Mountain Geologic Fault

Model Boundary Type

- Specified Flux Boundary
- NERT Property Boundary
- Phase 6 Model Extent

N

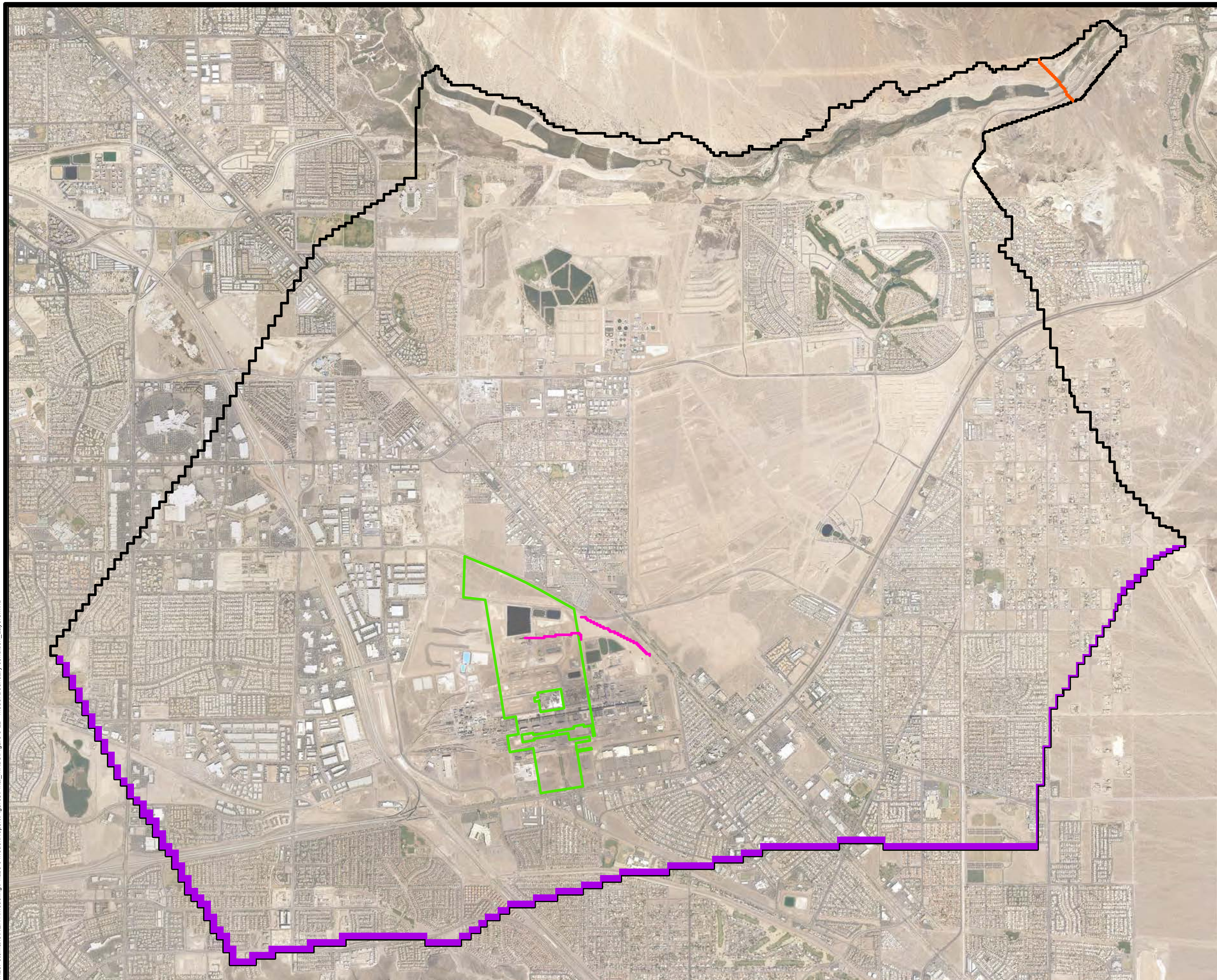
0 0.5 1 Miles

RAMBOLL

Model Boundary Conditions in Layer 2
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: AS/RS	Approved:	Revised:	5-10

Path: H:\LePetomane\NERTModeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-10 - Model Boundary condition_Layer2.mxd

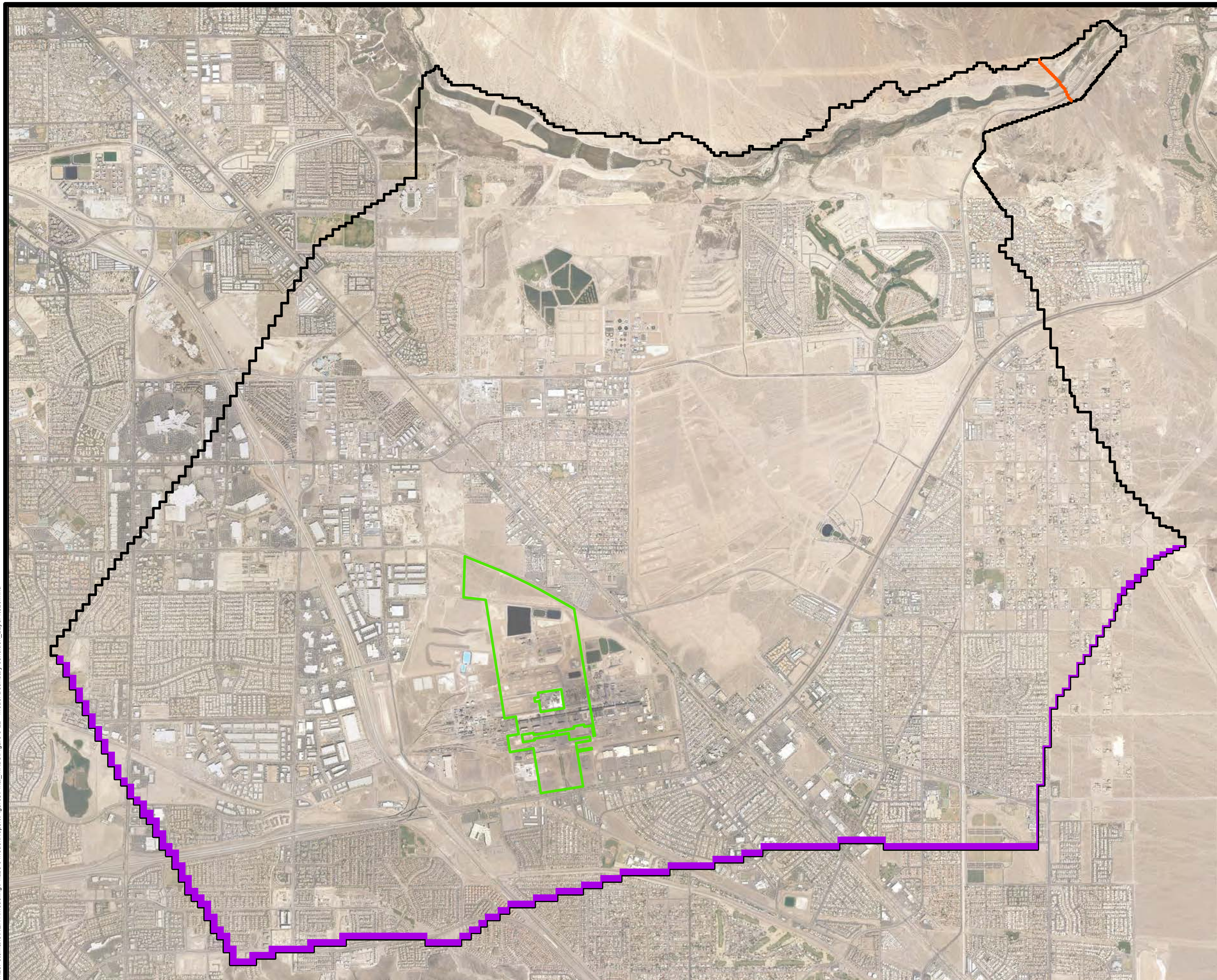


RAMBOLL

Model Boundary Conditions in Layer 3
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: AS/RS	Approved:	Revised:	5-11

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-11 - Model Boundary condition_Layer3.mxd



EXPLANATION

Horizontal Flow Barrier Boundary

Frenchman Mountain Geologic Fault

Model Boundary Type

Specified Flux Boundary

NERT Property Boundary

Phase 6 Model Extent

N

0 0.5 1 Miles

RAMBOLL

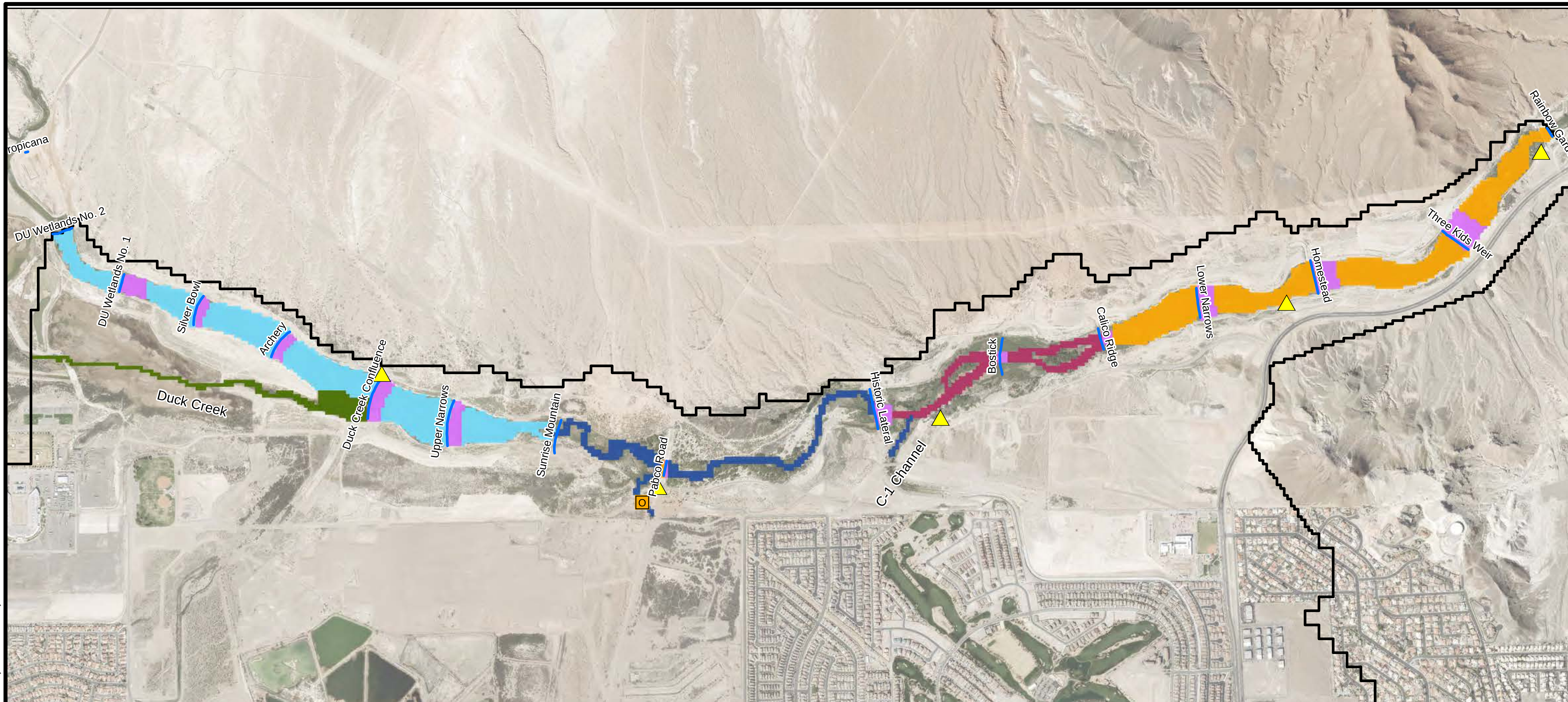
Model Boundary Conditions in Layer 4 to 10

Nevada Environmental Response Trust Site

Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: AS/RS	Approved:	Revised:	5-12

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-12 - Model Boundary condition_Layer4to10.mxd



EXPLANATION

- NERT/AMPAC (Endeavour)/TIMET/COH Outfall Location
- USGS Stream Gage Station
- SNWA Weirs
- Phase 6 Model Extent

Streambed Hydraulic Conductivity (ft/d)

- 9.8×10^{-4}
- 5.8×10^{-3}
- 1.1×10^{-1}
- 1.2×10^{-1}
- 7.1×10^{-2}
- 2.2×10^{-1}

Notes:

ft/d = feet per day
NERT = Nevada Environmental Response Trust
AMPAC = American Pacific Corporation, now Endeavour LLC
TIMET = Titanium Metals Corporation
COH = City of Henderson
SNWA = Southern Nevada Water Authority
USGS = United States Geological Survey

N

0 0.25 0.5 Miles

RAMBOLL

DRAFTED BY: LR | DATE: 11/19/2019

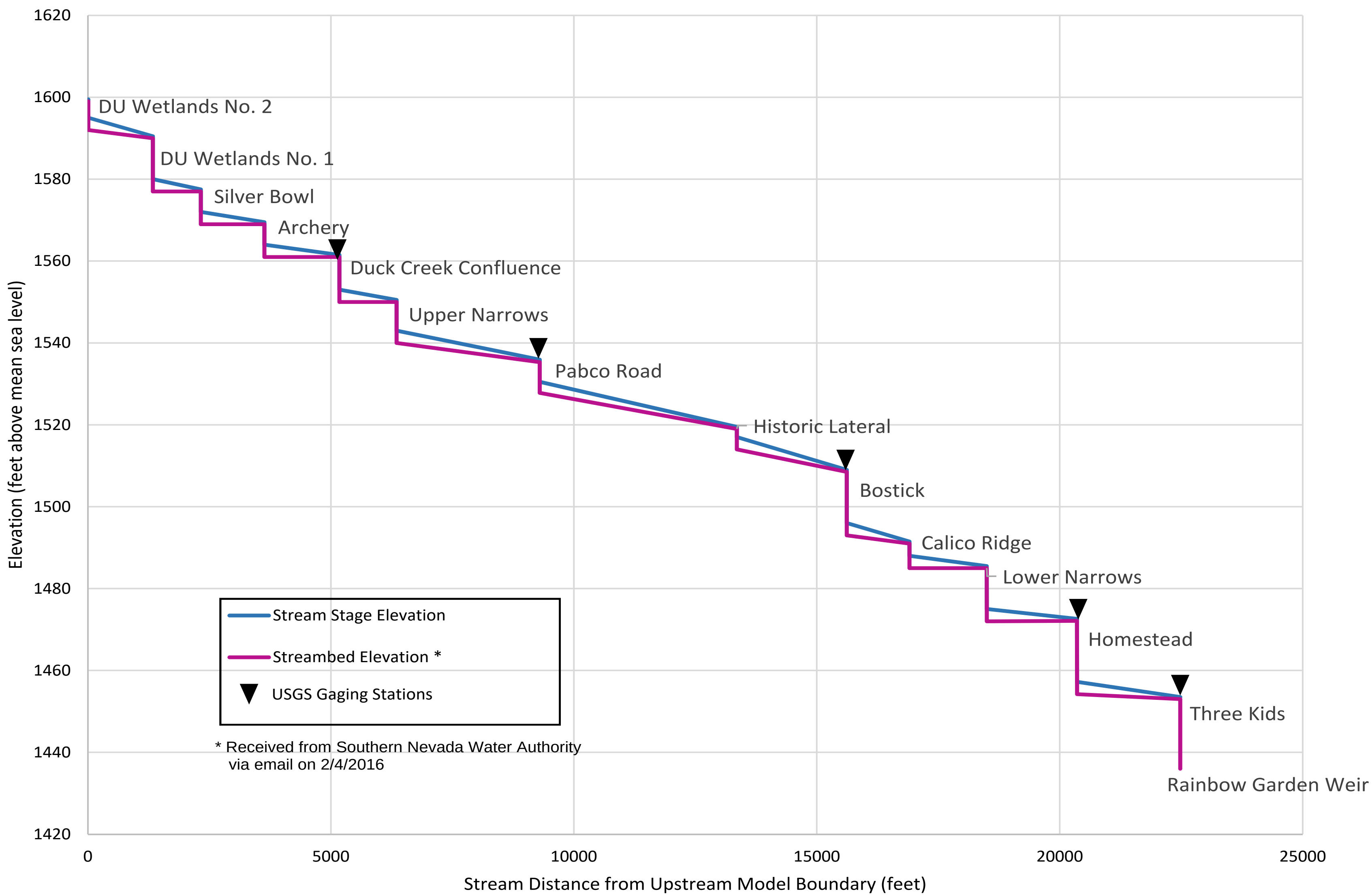
STREAMBED HYDRAULIC CONDUCTIVITY

Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
5-13

PROJECT: 1690011200-034

H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 5-13 - Streambed Hydraulic Conductivity.mxd



RAMBOLL

STREAM STAGE AND STREAMBED ELEVATION OF LAS VEGAS WASH
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
5-14

Drafter: AS | Date: 10/22/2019 | Contract Number: 1690011200-034 | Approved: | Revised:

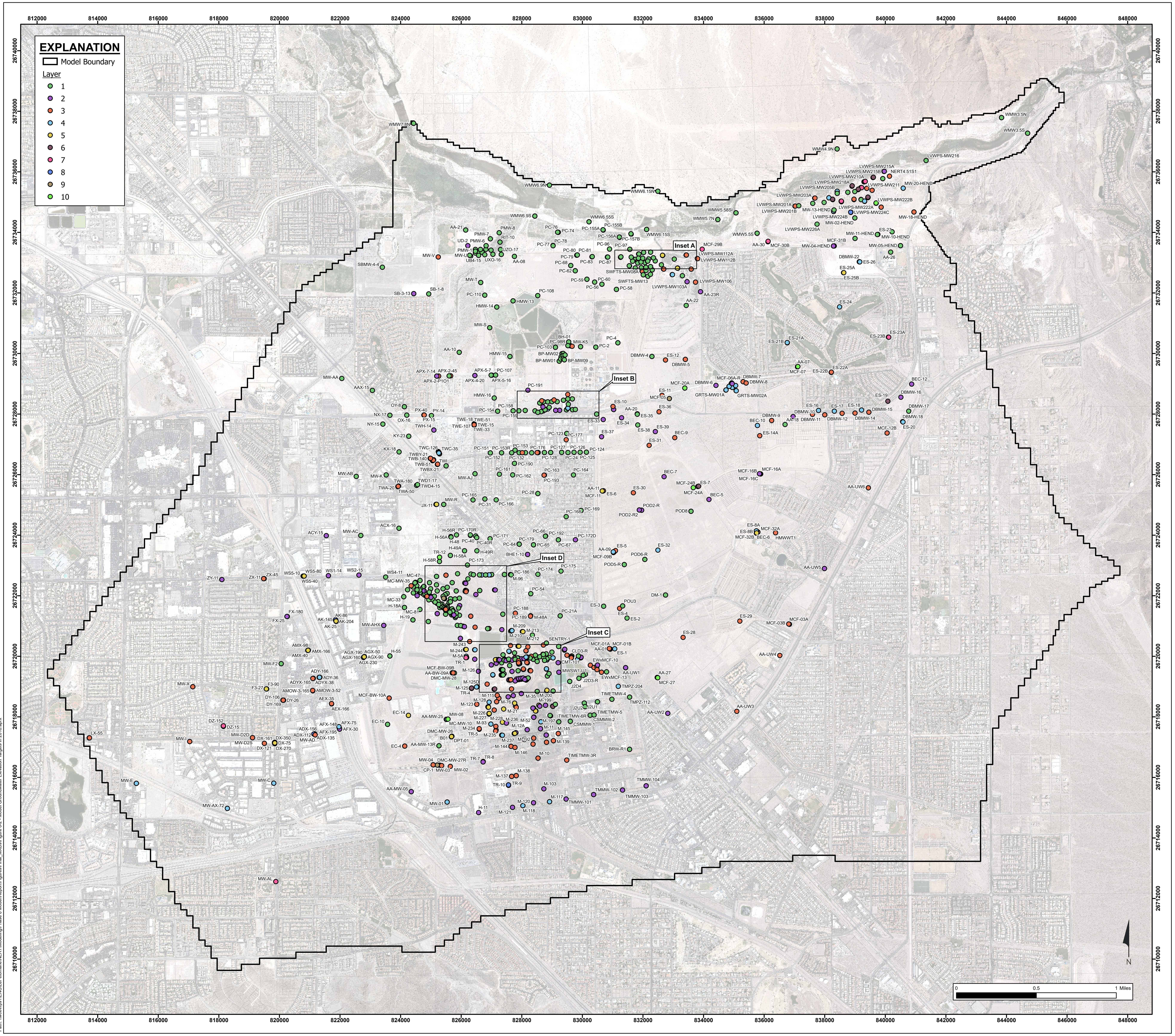
Figure 6-1

Model Groundwater Elevation Targets in 2014

Nevada Environmental Response Trust (NERT)
Henderson, Nevada

RAMBOLL

Coordinate System: NAD 1983 StatePlane Nevada East FIPS 2701 Feet Projection: Transverse Mercator Datum: North American 1983	PROJECT: 1690011200-034	DRAFTED BY: RS	DATE: 11/22/2019



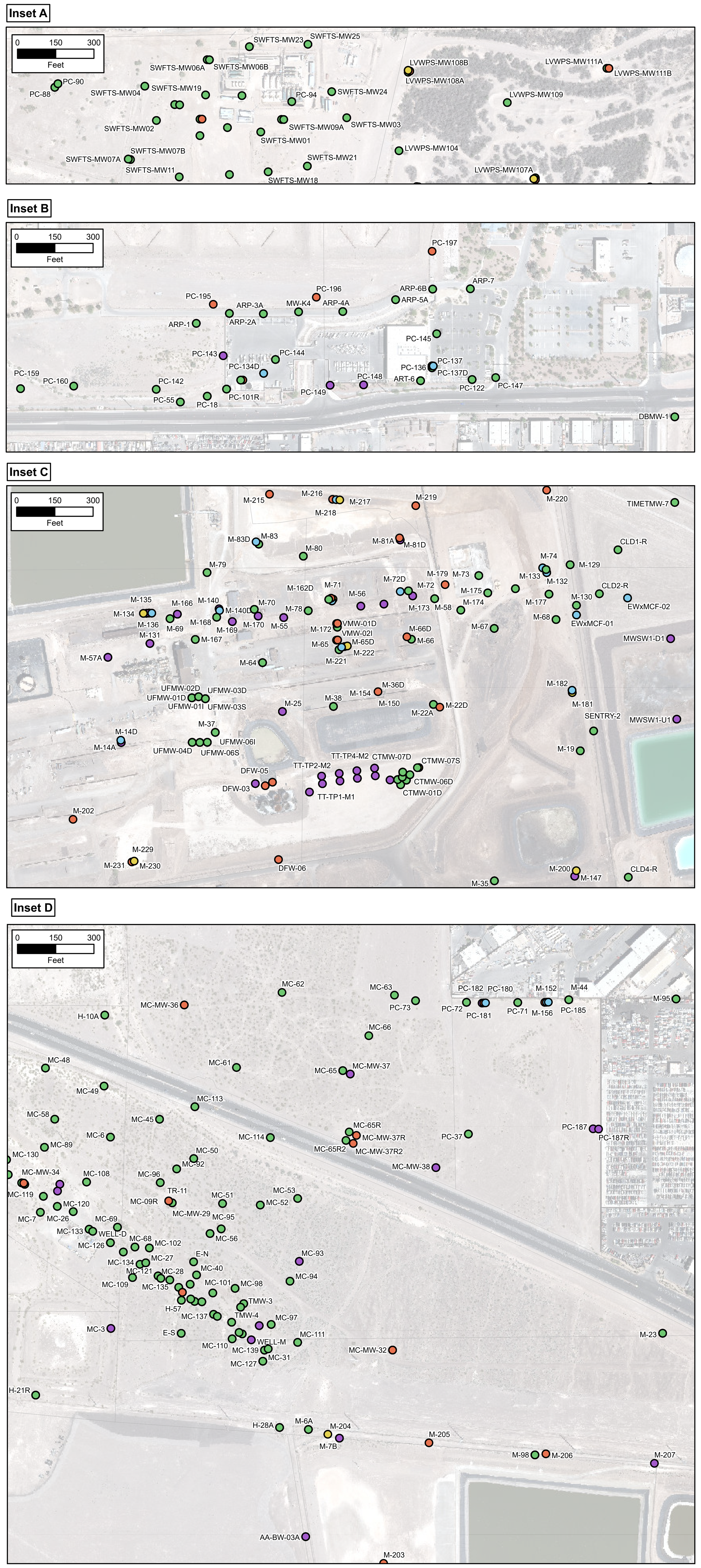


Figure 6-2

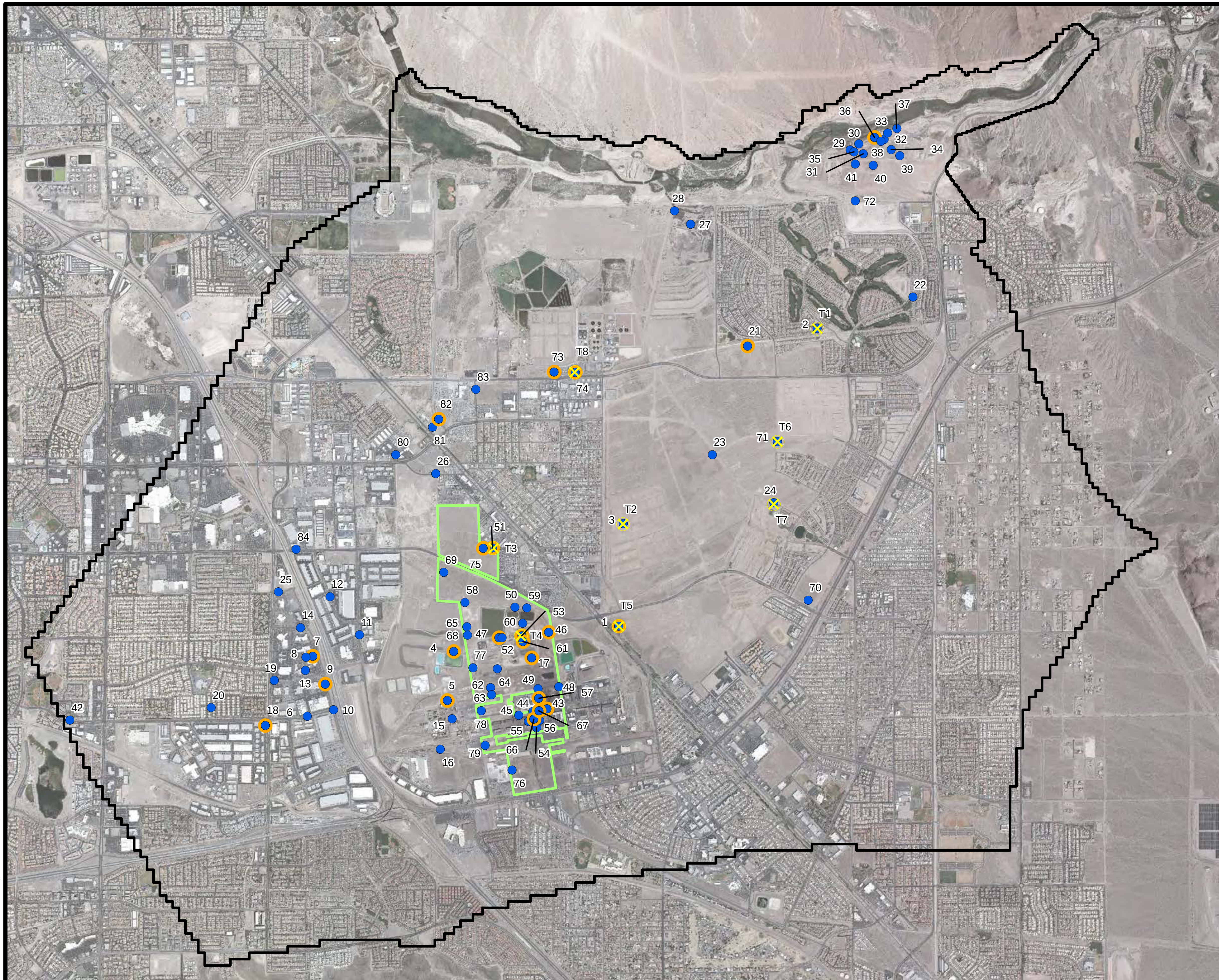
Model Groundwater Elevation Targets in 2018

Nevada Environmental Response Trust (NERT)
Henderson, Nevada

RAMBOLL

Coordinate System: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
Projection: Transverse Mercator
Datum: North American 1983

PROJECT: 1690011200-034 | DRAFTED BY: RS | DATE: 11/22/2019



EXPLANATION

- Transducer Clusters
- Well Cluster
- Well Cluster with Reversed Simulated Vertical Gradient
- NERT Property Boundary
- Phase 6 Model Extent

N

0 0.5 1 Miles

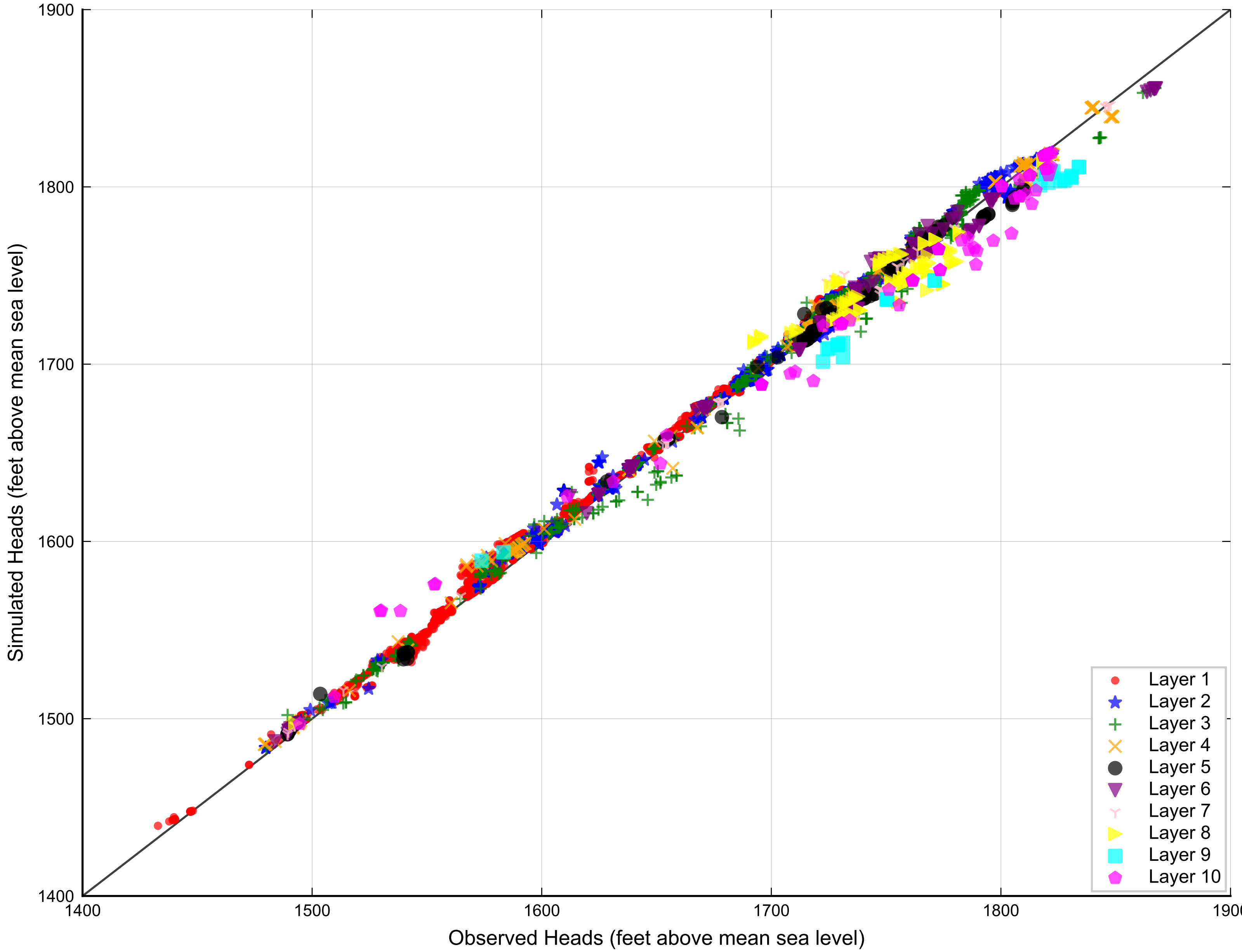
RAMBOLL

Vertical Head Difference Target Location
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: RZ	Approved:	Revised:	6-3

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 6-3 - Vertical Head Difference Target Location.mxd

Path: \\wcevlfps1\ENG\LePetomane\NERT\Modeling\Phase 6 Model\Model Post Processing_python scripts\NERT_scatterplot.py

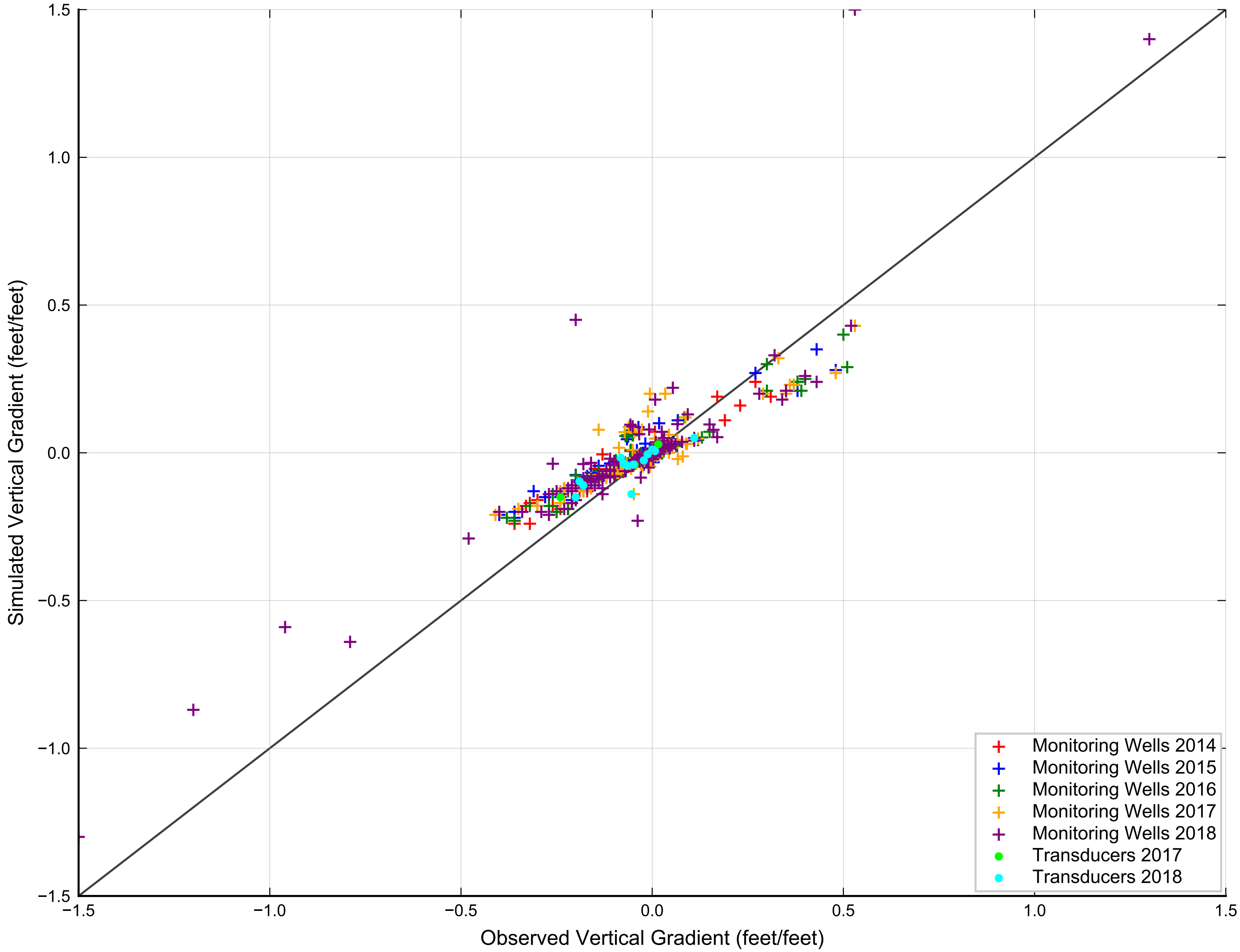


RAMBOLL

Observed versus Simulated Groundwater Elevations
Nevada Environmental Response Trust Site
Henderson Nevada

Figure
6-4

Drafter: KZ | Date: 11/19/19 | Contract Number: 1690011200-034 | Approved: | Revised:



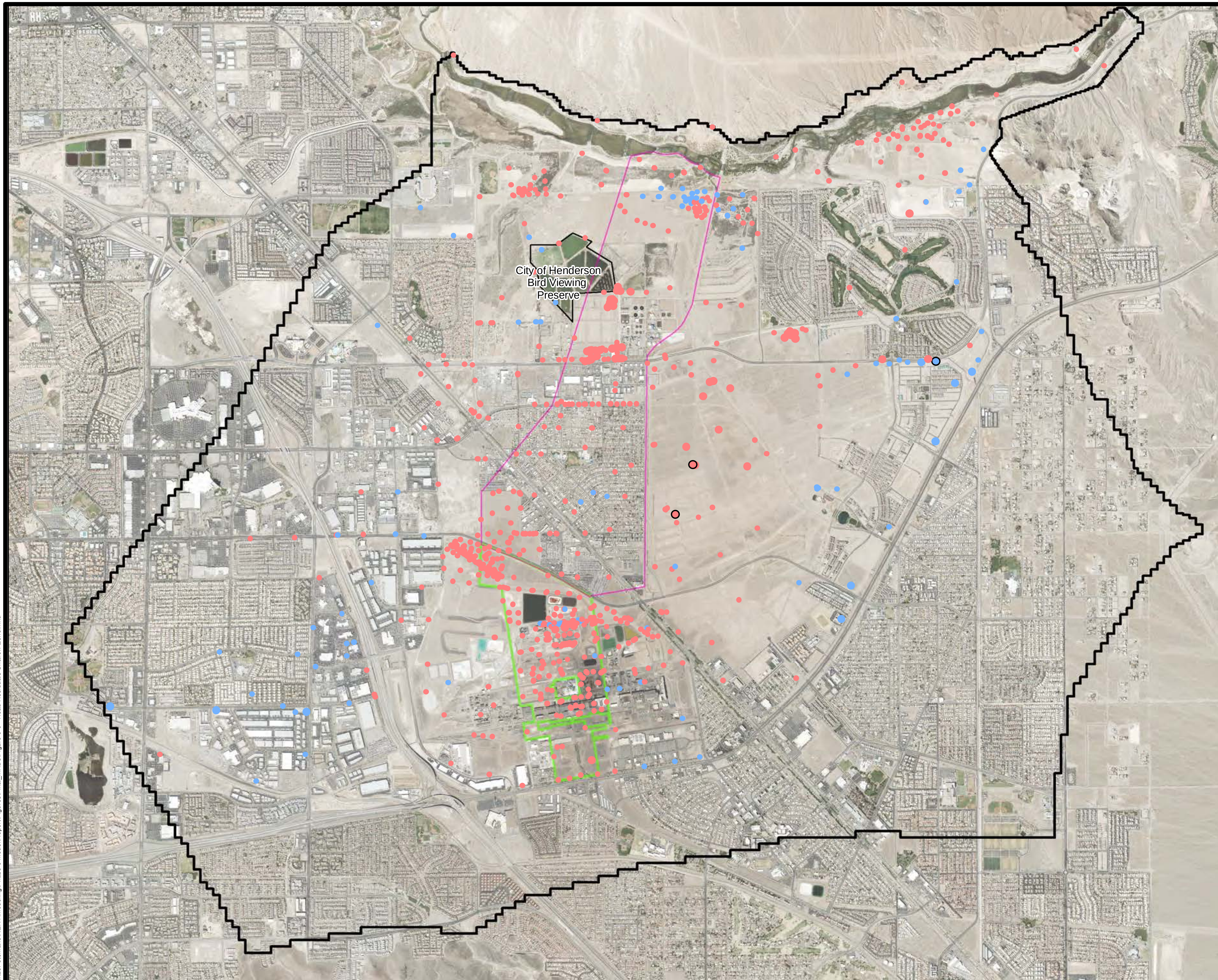
RAMBOLL

Observed versus Simulated Vertical Gradients
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure

6-5

Drafter: RZ | Date: 10/29/19 | Contract Number: 1690011200-034 | Approved: | Revised:



EXPLANATION

Head Residual (in feet)

- <-20
- -20 - -10
- -10 -0
- 0-10
- 10-20
- >20
- Off-site NERT RI Study Area
- NERT Property Boundary
- Phase 6 Model Boundary

Note: Average head residuals for each location over the model simulation period of 2014-2018.

N

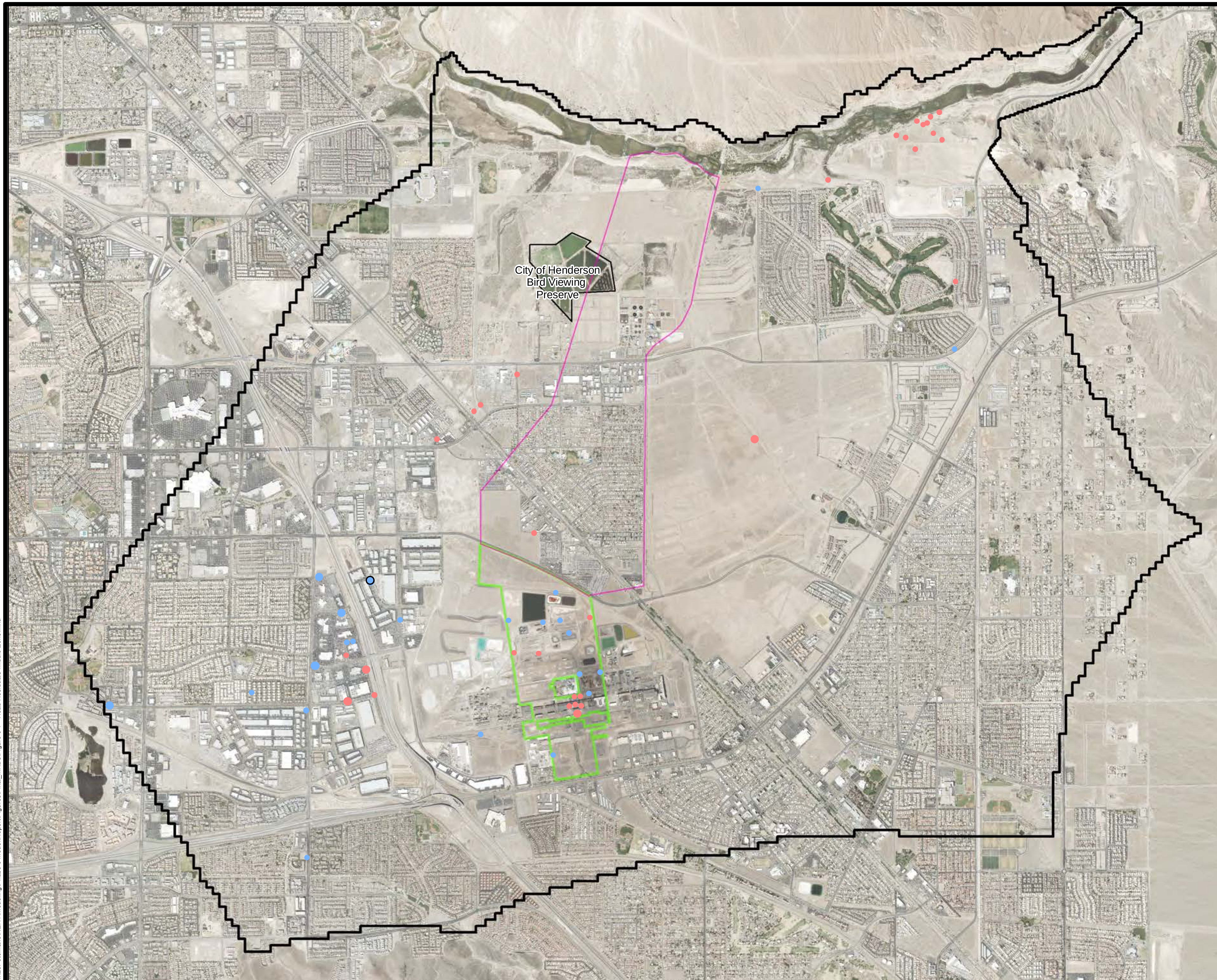
0 0.5 1 Miles

RAMBOLL

Head Residuals: Shallow Zone Wells
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 6-6
Drafter: AS/RS	Approved:	Revised:	

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 6-6 - Head Residuals-Shallow Zone.mxd



EXPLANATION

Head Residual (in feet)

- <-20
- -20 - -10
- -10 -0
- 0-10
- 10-20
- >20
- Off-site NERT RI Study Area
- NERT Property Boundary
- Phase 6 Model Boundary

Note: Average head residuals for each location over the model simulation period of 2014-2018.

N

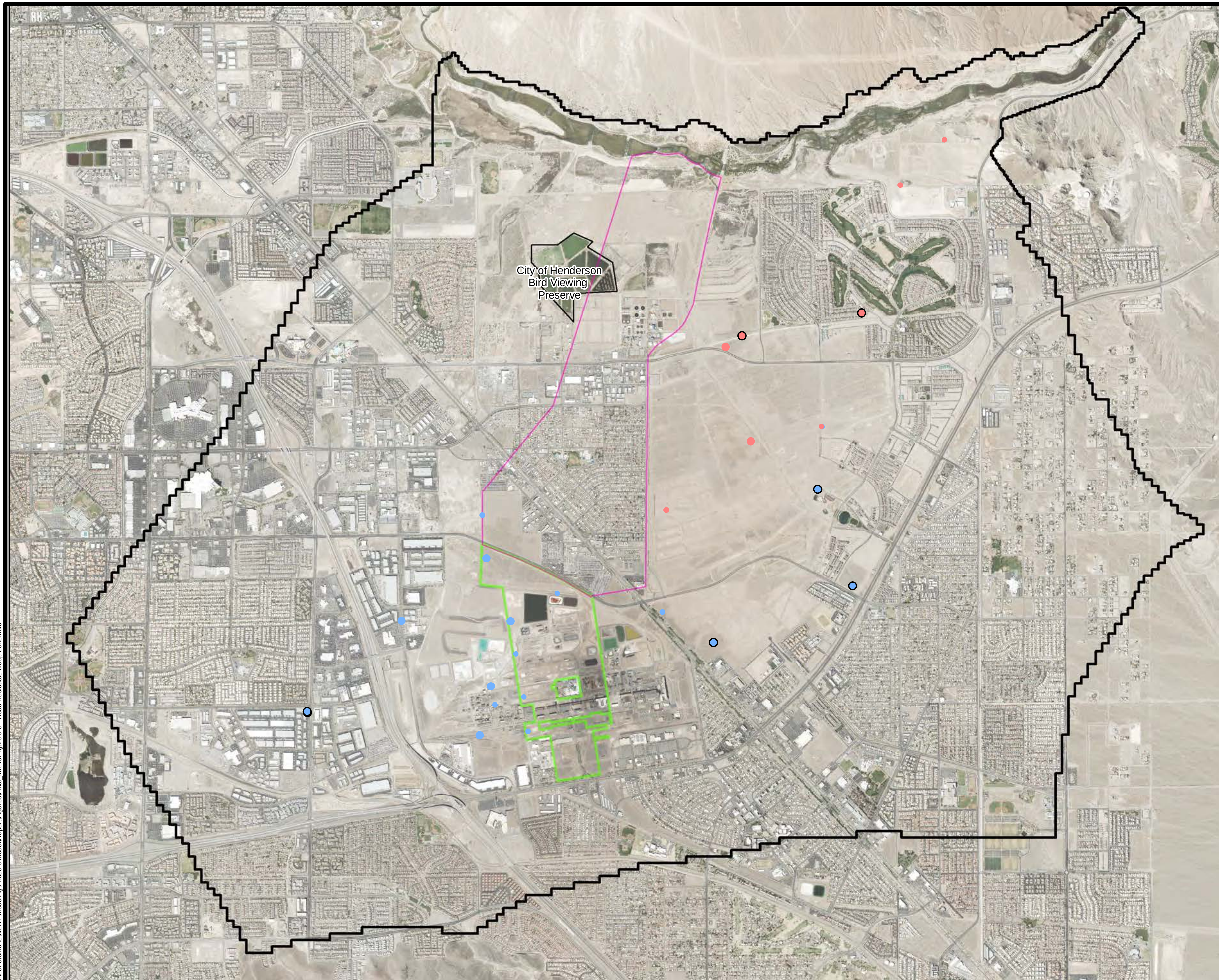
0 0.5 1 Miles

RAMBOLL

Head Residuals: Middle Zone Wells
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: AS/RS	Approved:	Revised:	6-7

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 6-7 - Head Residuals-Middle Zone.mxd



EXPLANATION

Head Residual (in feet)

- <-20
- -20 - -10
- -10 -0
- 0-10
- 10-20
- >20
- Off-site NERT RI Study Area
- NERT Property Boundary
- Phase 6 Model Boundary

Note: Average head residuals for each location over the model simulation period of 2014-2018.

N

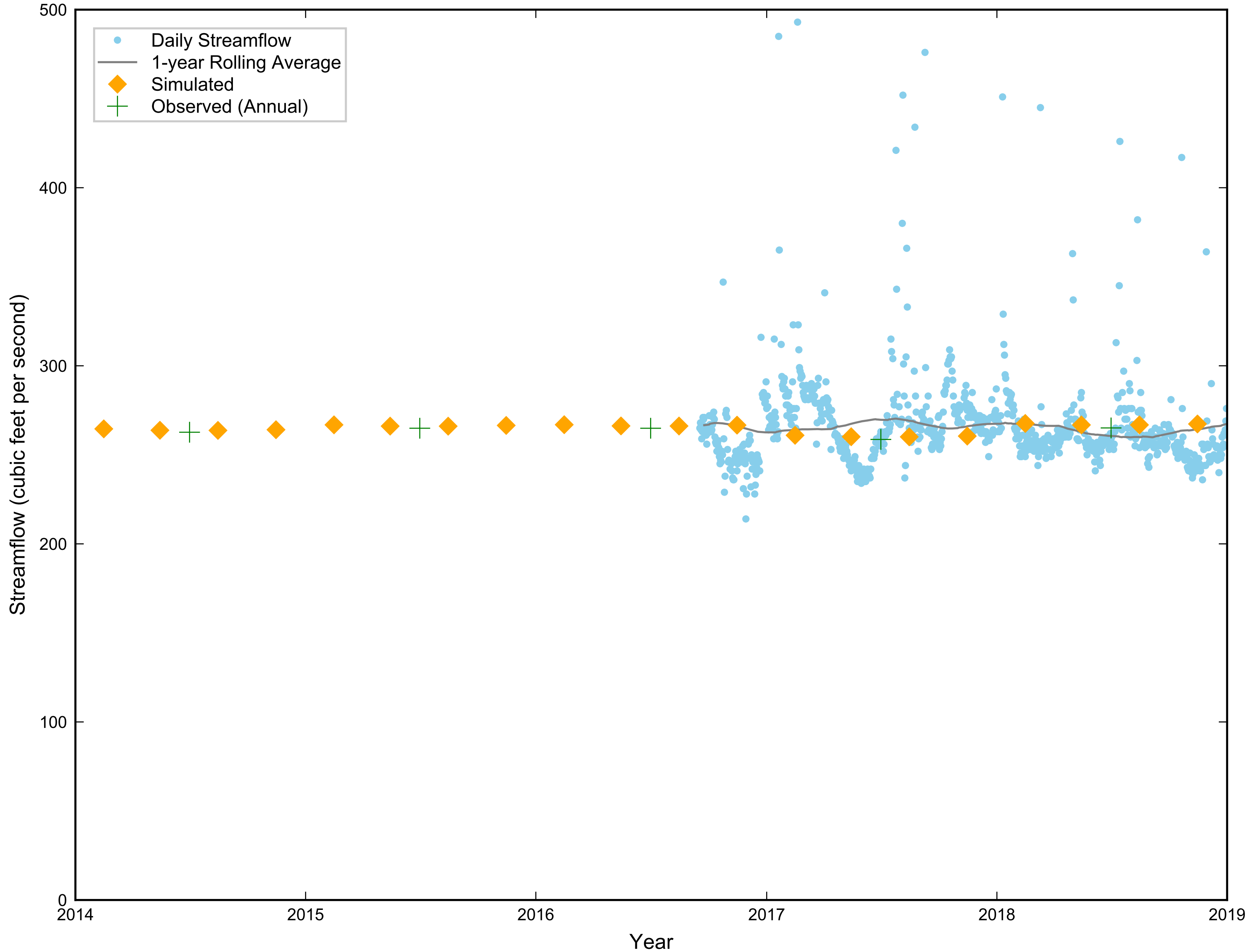
0 0.5 1 Miles

RAMBOLL

Head Residuals: Deep Zone Wells
Nevada Environmental Response Trust Site
Henderson, NV

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 6-8
Drafter: AS/RS	Approved:	Revised:	

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 6-8 - Head Residuals-Deep Zone.mxd



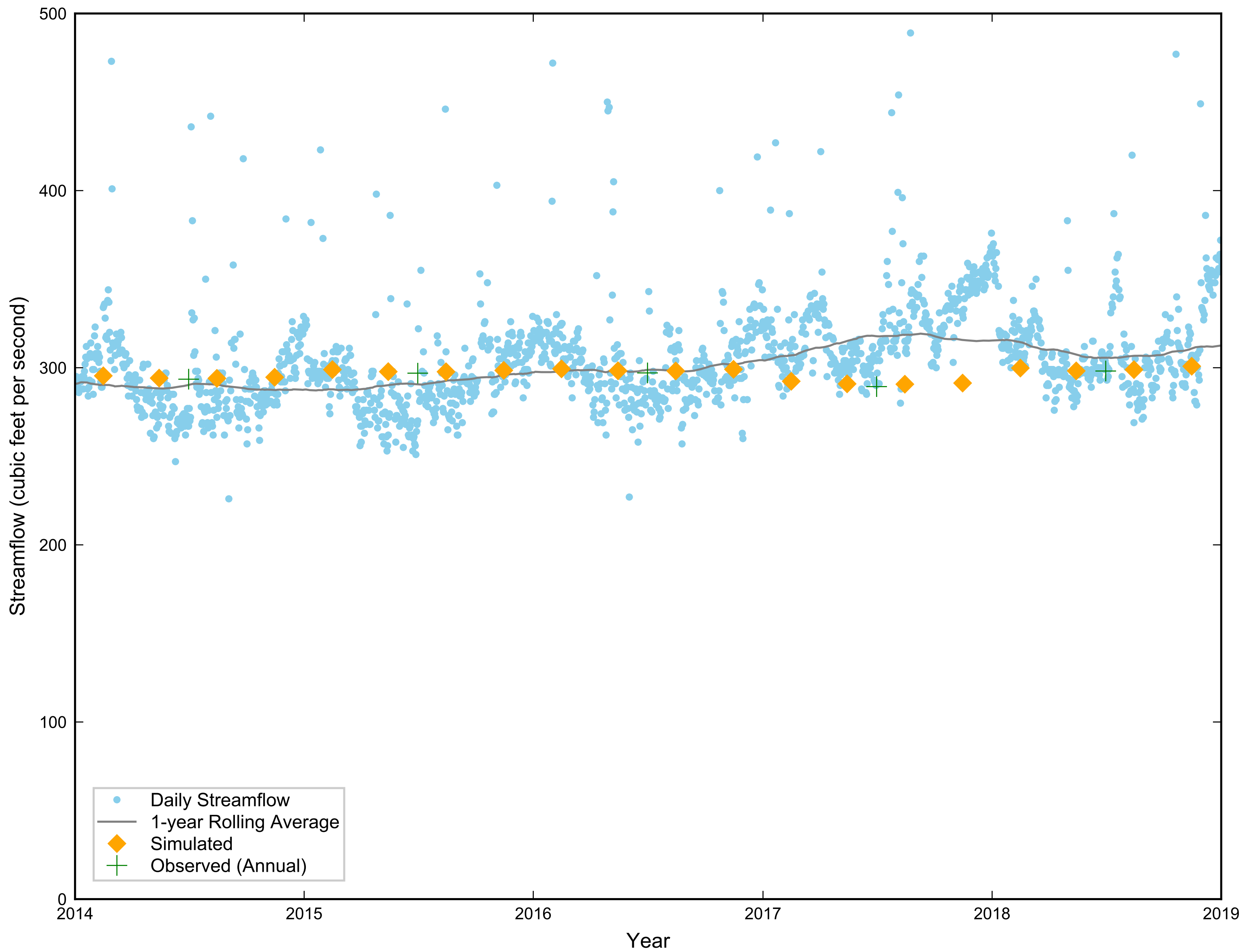
RAMBOLL

Observed versus Simulated Streamflow at Duck Creek Confluence Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
6-9

Drafter: RZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:

ramboll\projects\NERT\Modeling\Phase_6\figures\ph6_LVW_stream_plot.py



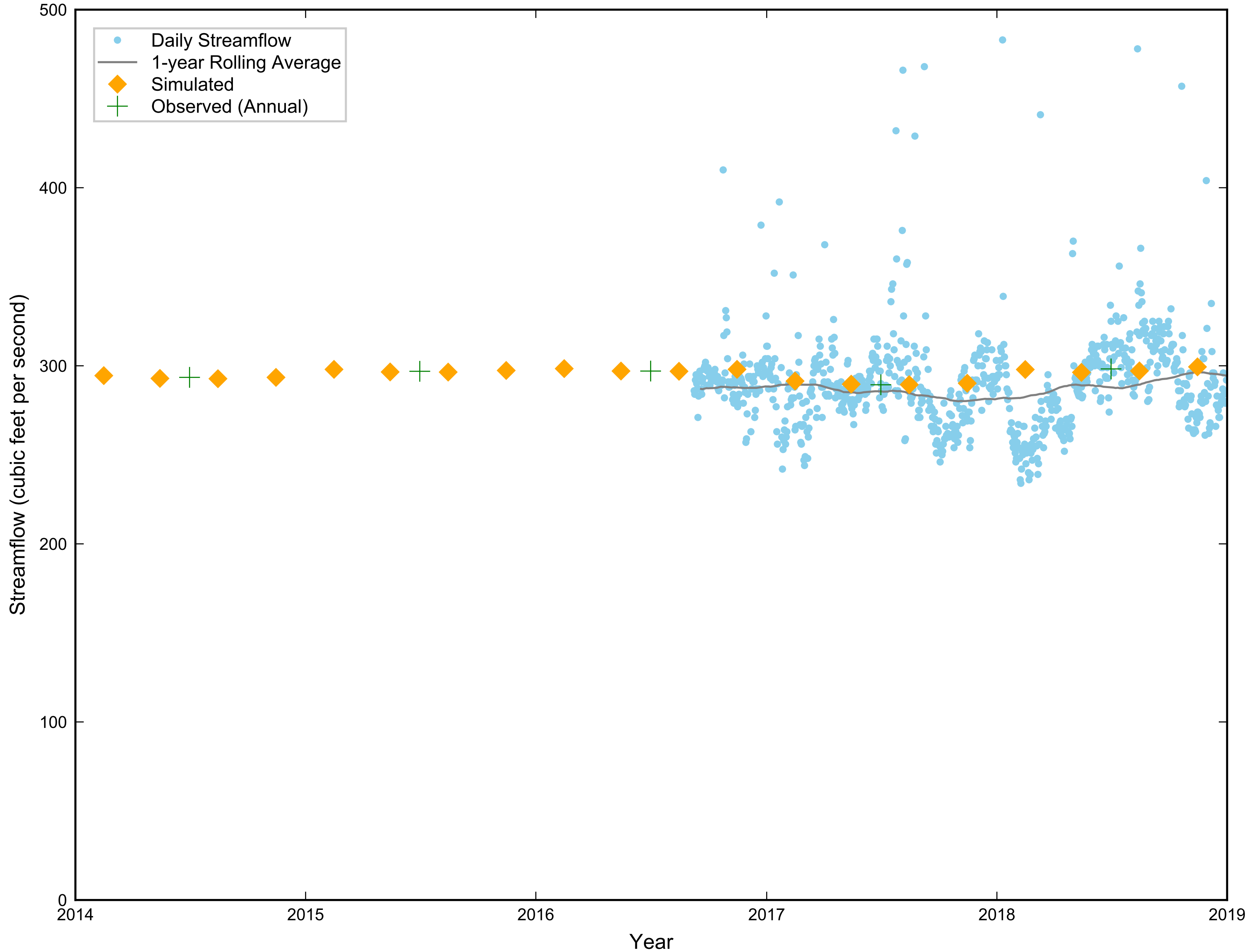
RAMBOLL

Observed versus Simulated Streamflow at Pabco Road Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
6-10

Drafter: RZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:

ramboll\projects\NERT\Modeling\Phase_6\figures\ph6_LVW_stream_plot.py



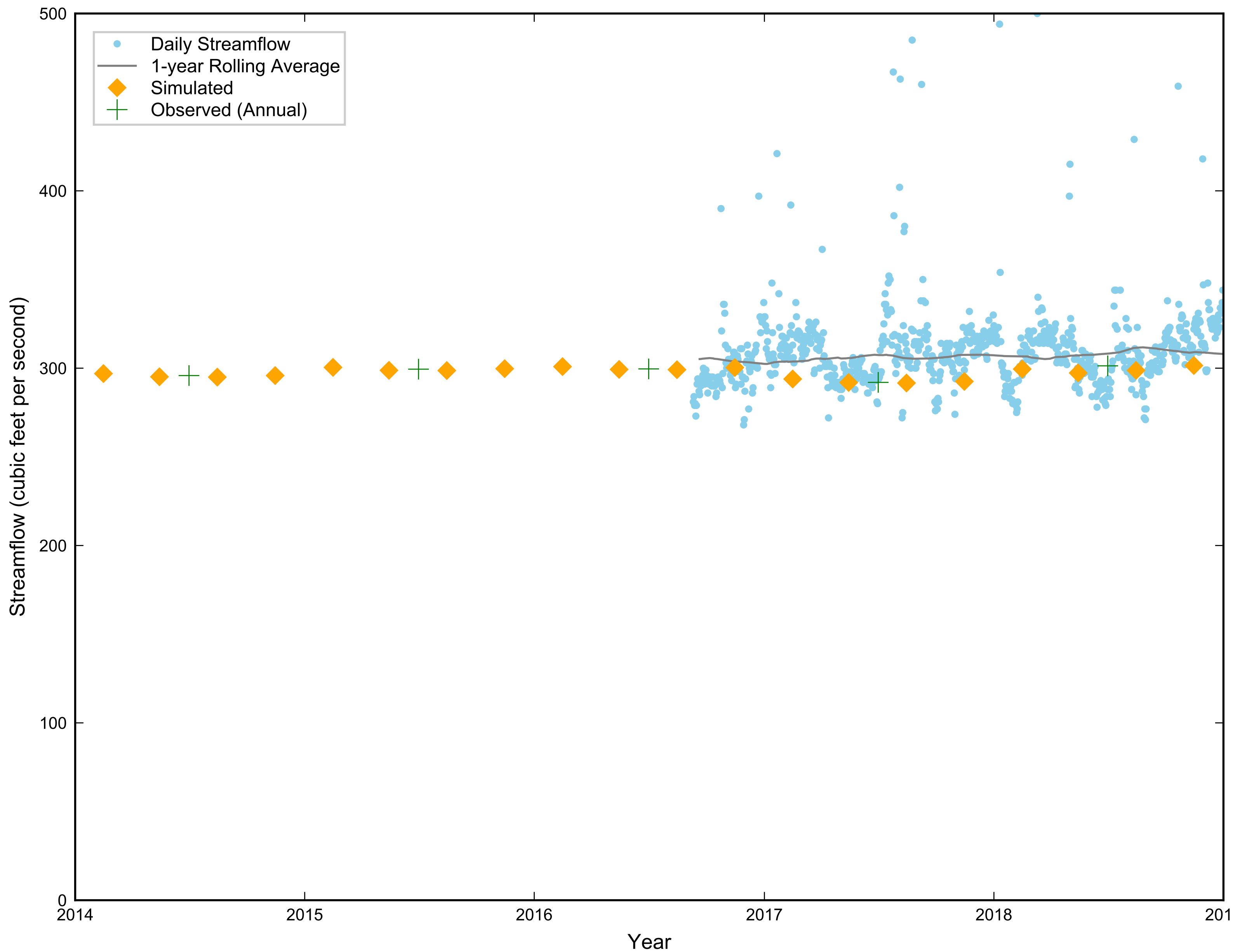
RAMBOLL

Observed versus Simulated Streamflow at Bostic Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
6-11

Drafter: RZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:

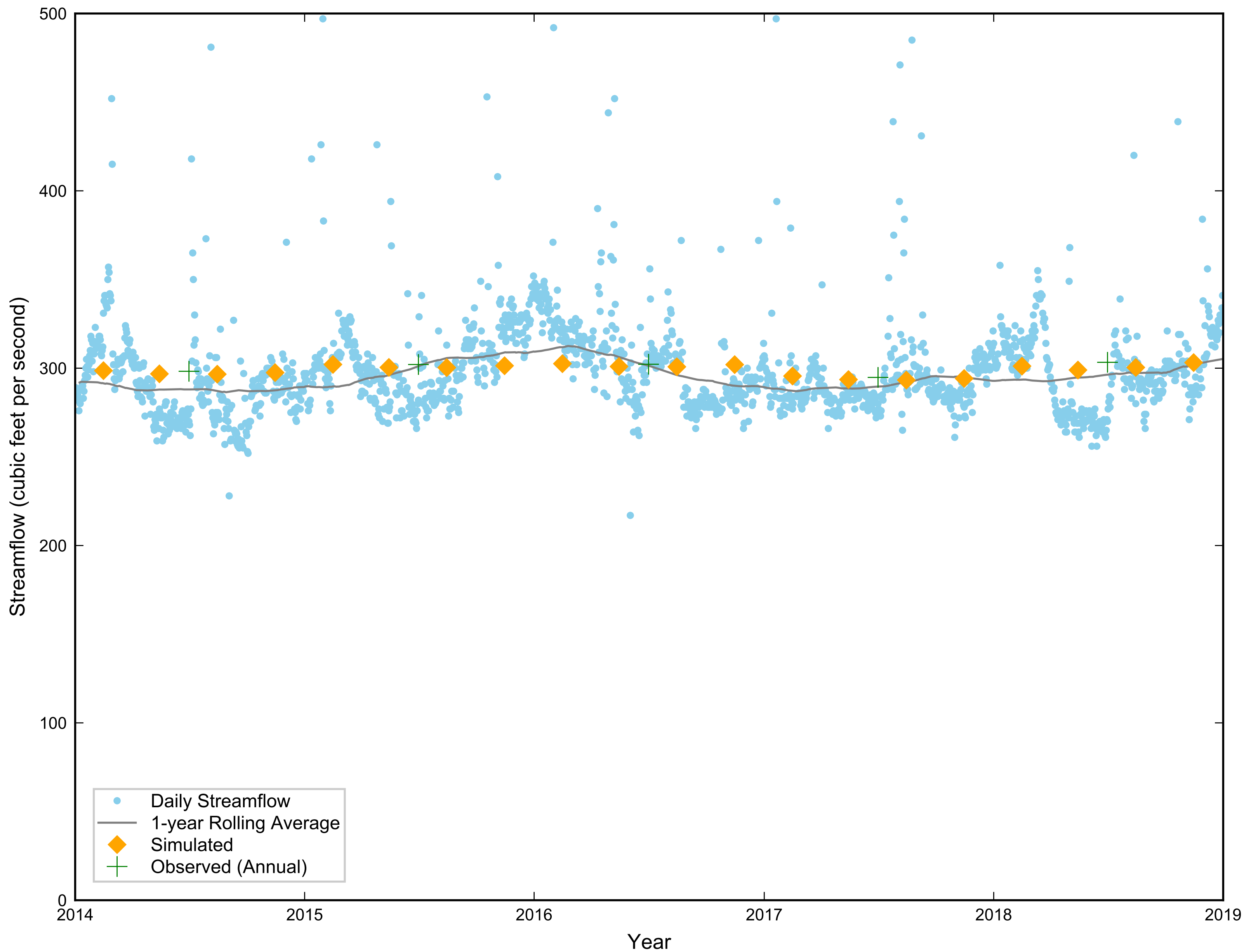
ramboll\projects\NERT\Modeling\Phase_6\figures\ph6_LVW_stream_plot.py



Observed versus Simulated Streamflow at Homestead Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
6-12

Drafter: RZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:



Observed versus Simulated Streamflow at Three Kids Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
6-13

Drafter: RZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:

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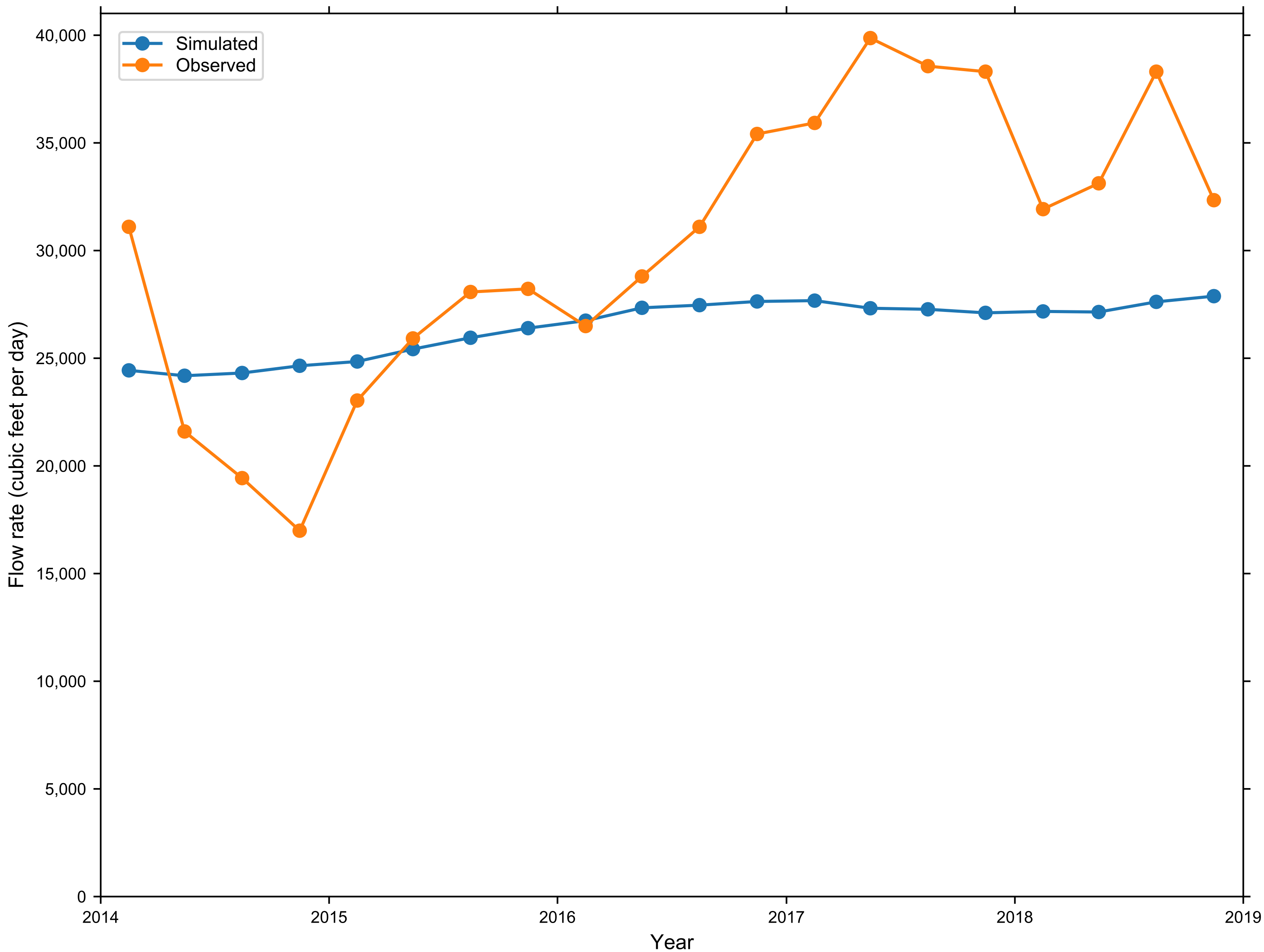
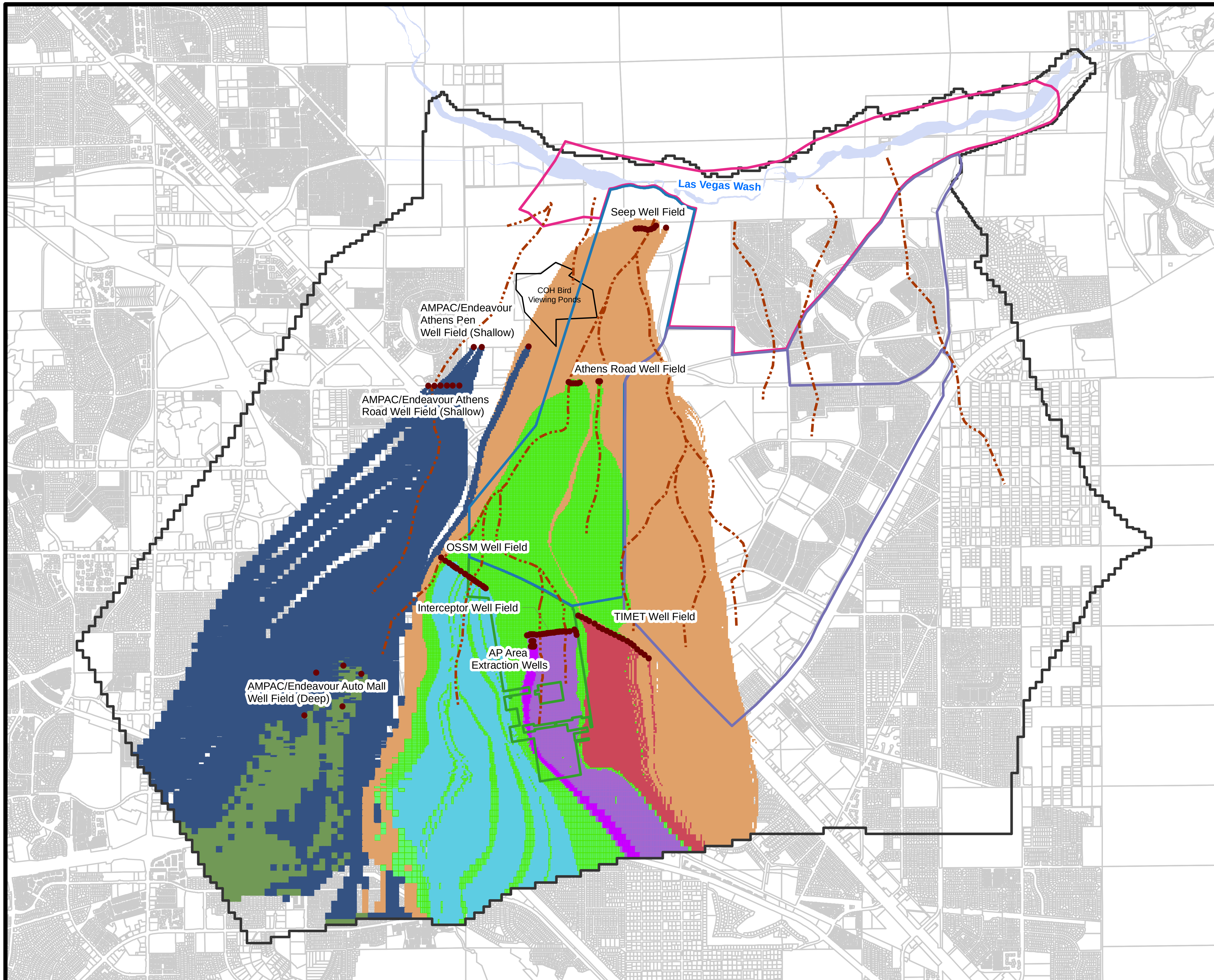


Observed versus Simulated Drain Discharge at Athens Main Drainage Channel
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
6-14

Drafter: RZ | Date: 10/30/19 | Contract Number: 1690011200-034 | Approved: | Revised:



EXPLANATION

- Extraction Wells
- Revised Paleochannels
- Downgradient Study Area
- Eastside Study Area
- NERT Off-Site Study Area
- NERT Property Boundary
- Phase 6 Model Boundary

Capture Zones

- Interceptor Well Field
- Athens Road Well Field
- Seep Well Field
- OSSM Well Field
- TIMET Well Field
- AMPAC/Endeavour - Shallow Extraction Wells
- AMPAC/Endeavour - Deep Extraction Wells
- AP Area Extraction Wells

AMPAC/Endeavour = American Pacific Corporation, now Endeavour LLC
OSSM = Olin/Stauffer/Syngenta/Montrose
TIMET = Titanium Metals Corporation
COH = City of Henderson
WBZ = Water-Bearing Zone

N

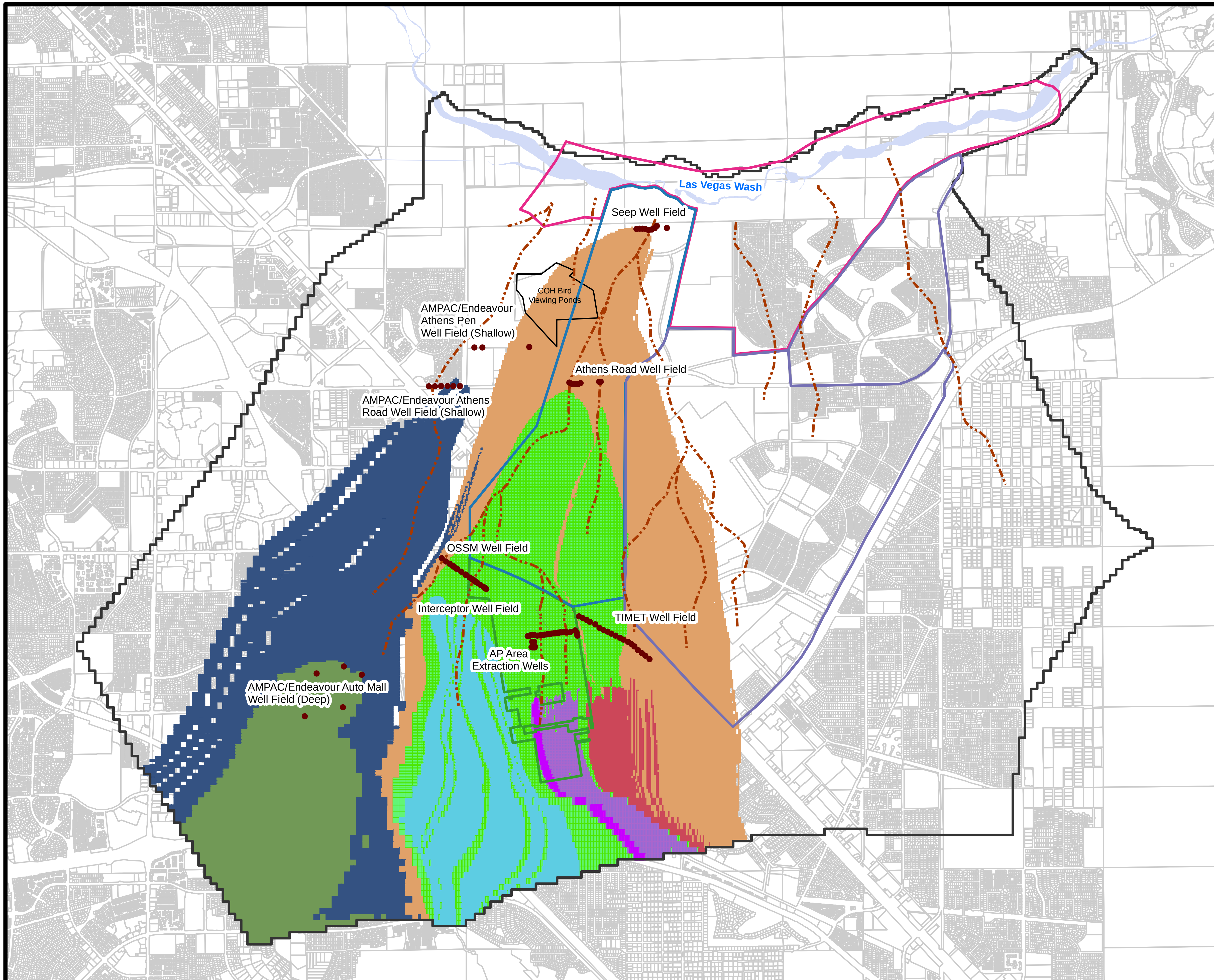
0 0.5 1 Miles

RAMBOLL

SHALLOW CAPTURE ZONES
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 6-15
Drafter: AS	Approved:	Revised:	

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 6-15 - Capture Zone- Shallow.mxd



EXPLANATION

- Extraction Wells
- Revised Paleochannels
- Downgradient Study Area
- Eastside Study Area
- NERT Off-Site Study Area
- NERT Property Boundary
- Phase 6 Model Boundary

Capture Zones

- Interceptor Well Field
- Athens Road Well Field
- Seep Well Field
- OSSM Well Field
- TIMET Well Field
- AMPAC/Endeavour - Shallow Extraction Wells
- AMPAC/Endeavour - Deep Extraction Wells
- AP Area Extraction Wells

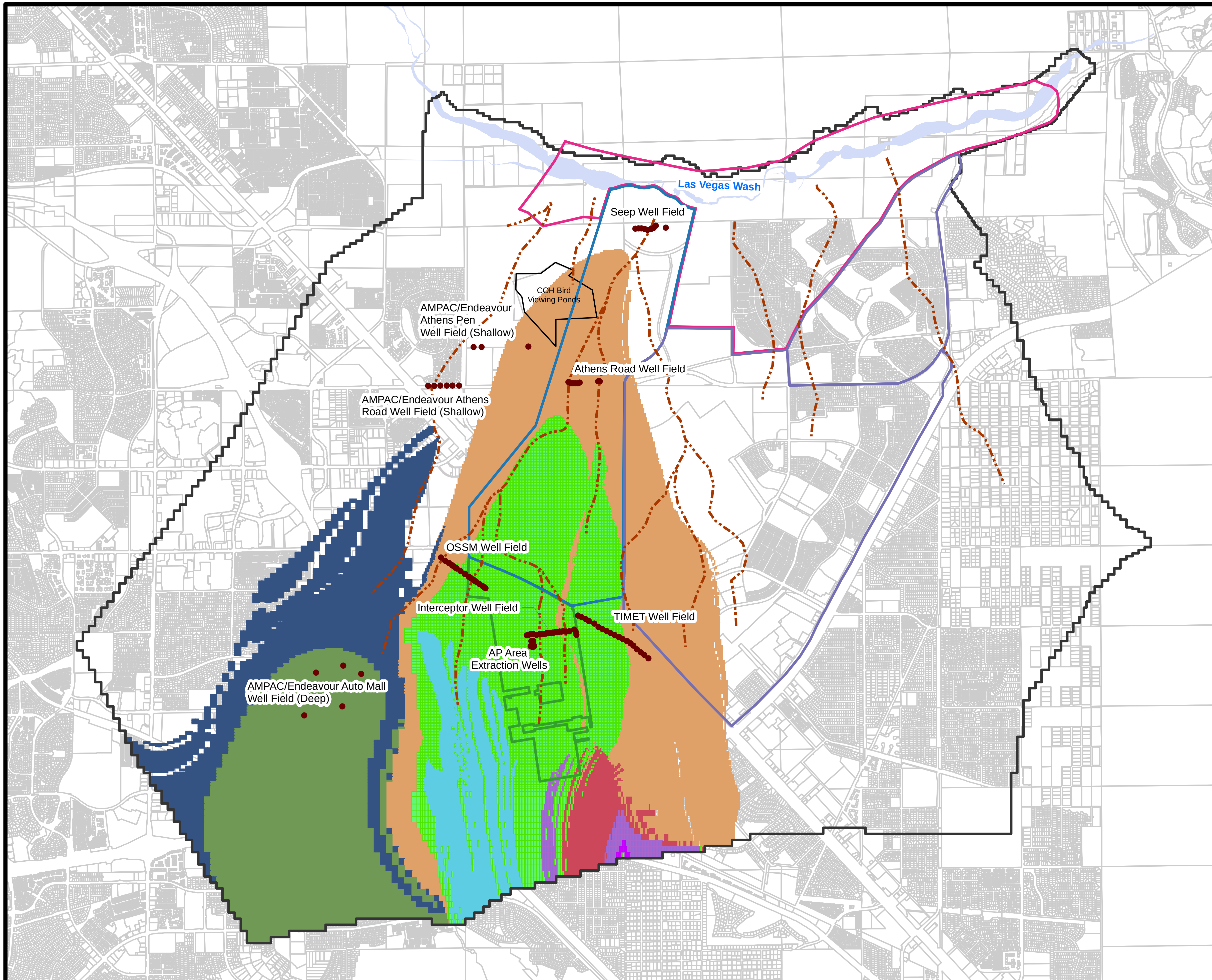
AMPAC/Endeavour = American Pacific Corporation, now Endeavour LLC
OSSM = Olin/Stauffer/Syngenta/Montrose
TIMET = Titanium Metals Corporation
COH = City of Henderson
WBZ = Water-Bearing Zone

RAMBOLL

MIDDLE CAPTURE ZONES
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 6-16
Drafter: AS	Approved:	Revised:	

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 6-16 - Capture Zone- Middle.mxd



EXPLANATION

- Extraction Wells
- Revised Paleochannels
- Downgradient Study Area
- Eastside Study Area
- NERT Off-Site Study Area
- NERT Property Boundary
- Phase 6 Model Boundary

Capture Zones

- Interceptor Well Field
- Athens Road Well Field
- Seep Well Field
- OSSM Well Field
- TIMET Well Field
- AMPAC/Endeavour - Shallow Extraction Wells
- AMPAC/Endeavour - Deep Extraction Wells
- AP Area Extraction Wells

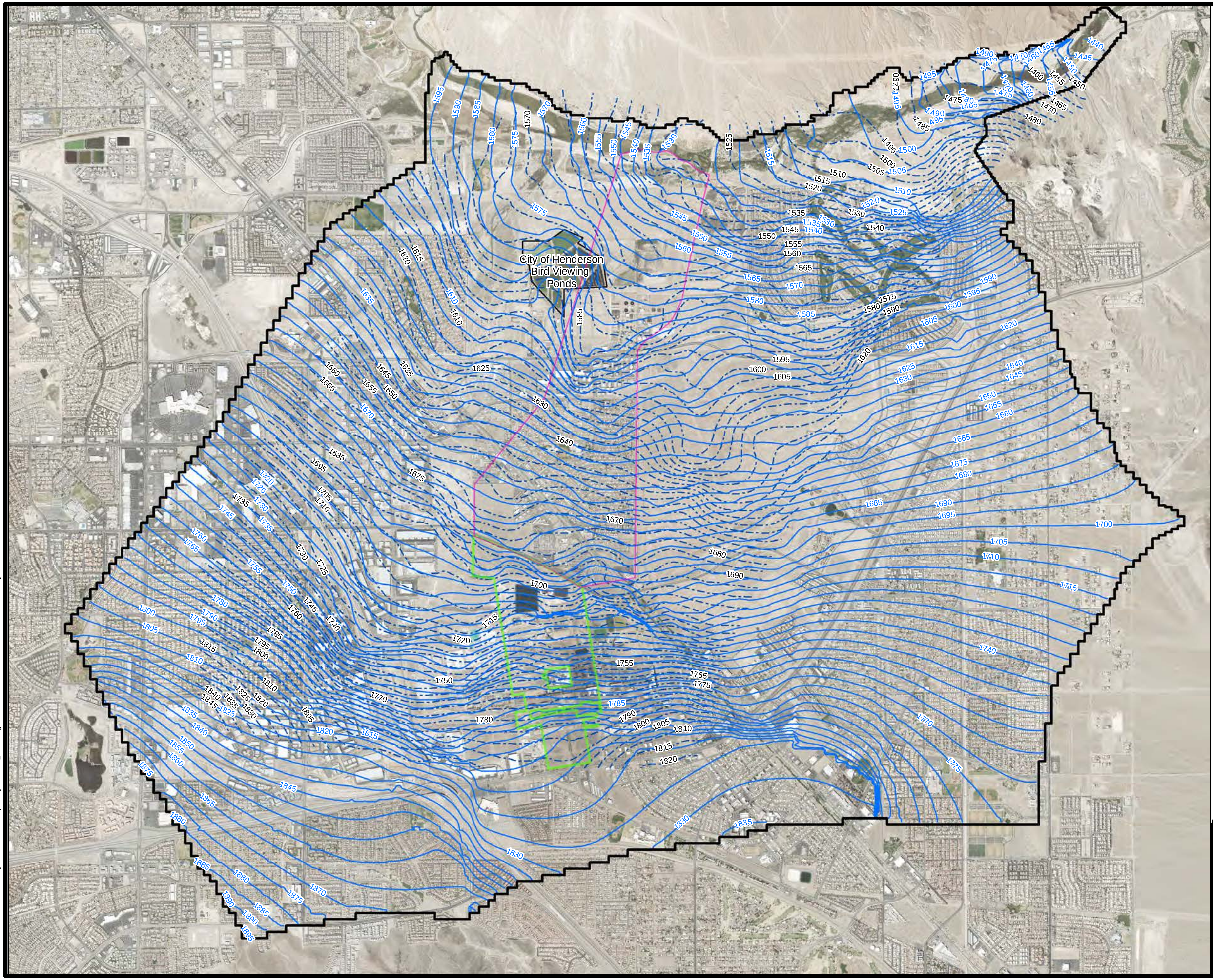
AMPAC/Endeavour = American Pacific Corporation, now Endeavour LLC
OSSM = Olin/Stauffer/Syngenta/Montrose
TIMET = Titanium Metals Corporation
COH = City of Henderson
WBZ = Water-Bearing Zone

RAMBOLL

DEEP CAPTURE ZONES
Nevada Environmental Response Trust Site
Henderson, Nevada

Date:	Contract Number:		Figure
11/19/2019	1690011200-034		6-17
Drafter: AS	Approved:	Revised:	

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 6-17 - Capture Zone- Deep.mxd



EXPLANATION

- NERT Off-Site RI Study Area
- NERT Property Boundary
- Phase 6 Model Boundary
- Simulated Heads (ft amsl)
- Observed Groundwater Elevations (ft amsl)*
- City of Henderson Bird Viewing Ponds

Notes:

ft amsl = feet above mean sea level

*Ramboll. 2018. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2017-June 2018. November 9.

N

0 0.5 1 Miles

RAMBOLL

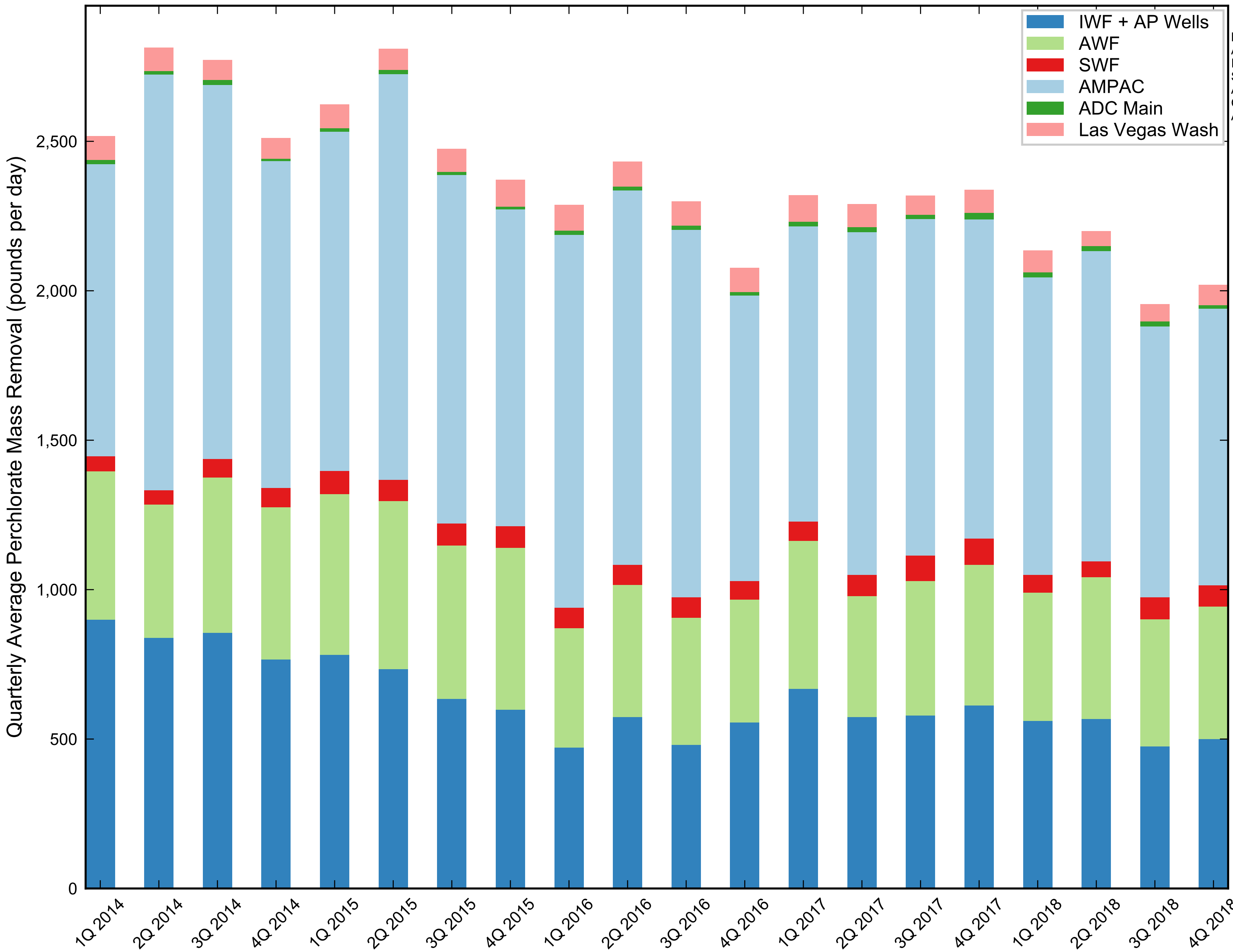
Simulated versus Observed Potentiometric Surface Map for Second Quarter 2018

Nevada Environmental Response Trust Site
Henderson, NV

Date:	Contract Number:		Figure
11/19/2019	1690011200-034		
Drafter:	Approved:	Revised:	
AS/RS			6-18

Path: H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 6-18- Potentiometric Surface Map for Second Quarter 2018.mxd

Path: \\wcevlfps1\ENG\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Draft_MXDs\Figures 6-1, 8-2 - Total Mass Loading\Mass_Loading_Figures.py



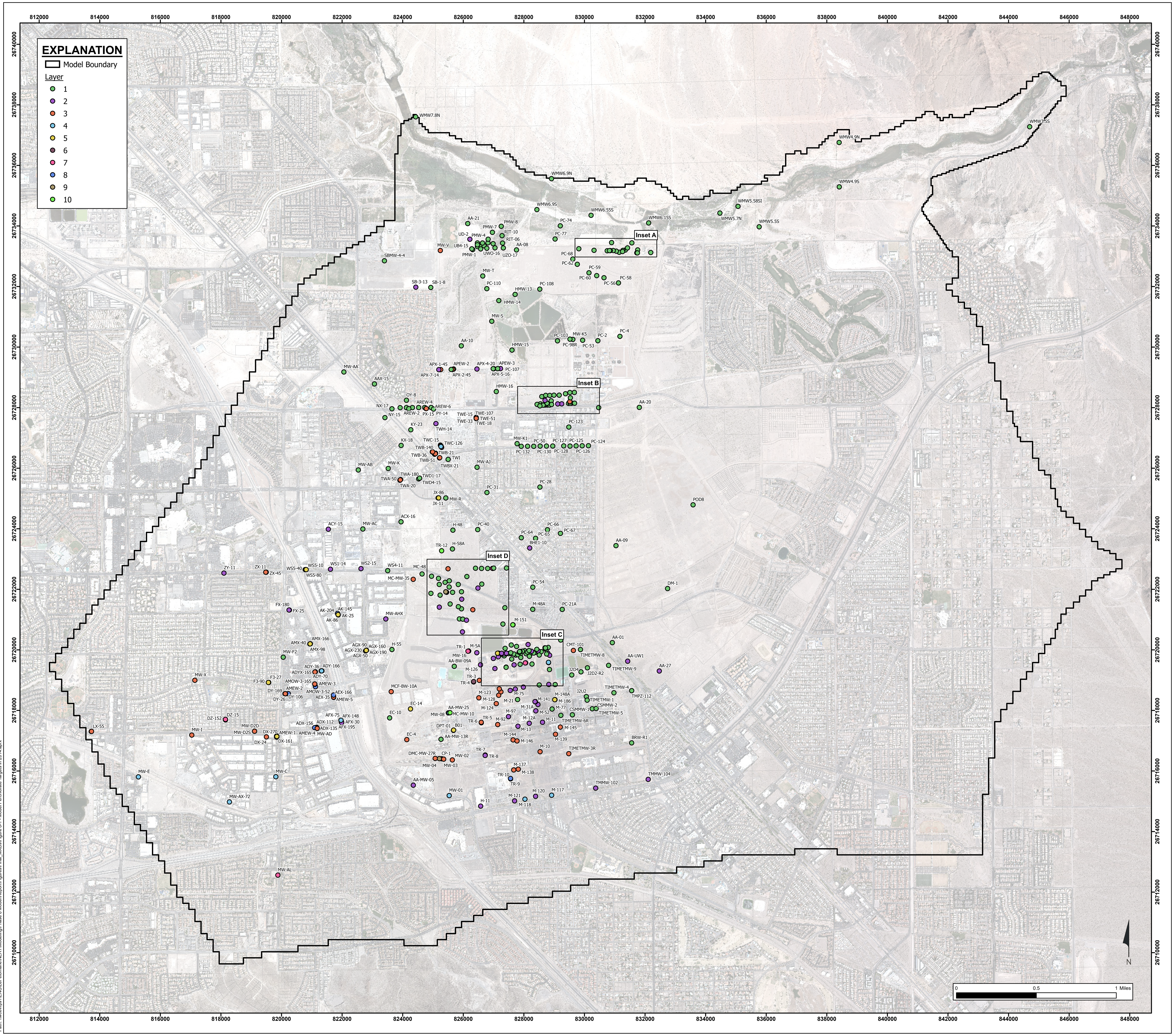
Note:
AWF = Athens Well Field
IWF = Interceptor Well Field
SWF = Seep Well Field
AMPAC = American Pacific Corporation, now Endeavour LLC
ADC = Athens Drainage Channel

RAMBOLL

Reported Perchlorate Mass Removal
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
7-1

Drafter: MFS | Date: 11/19/19 | Contract Number: 1690011200-034 | Approved: | Revised:



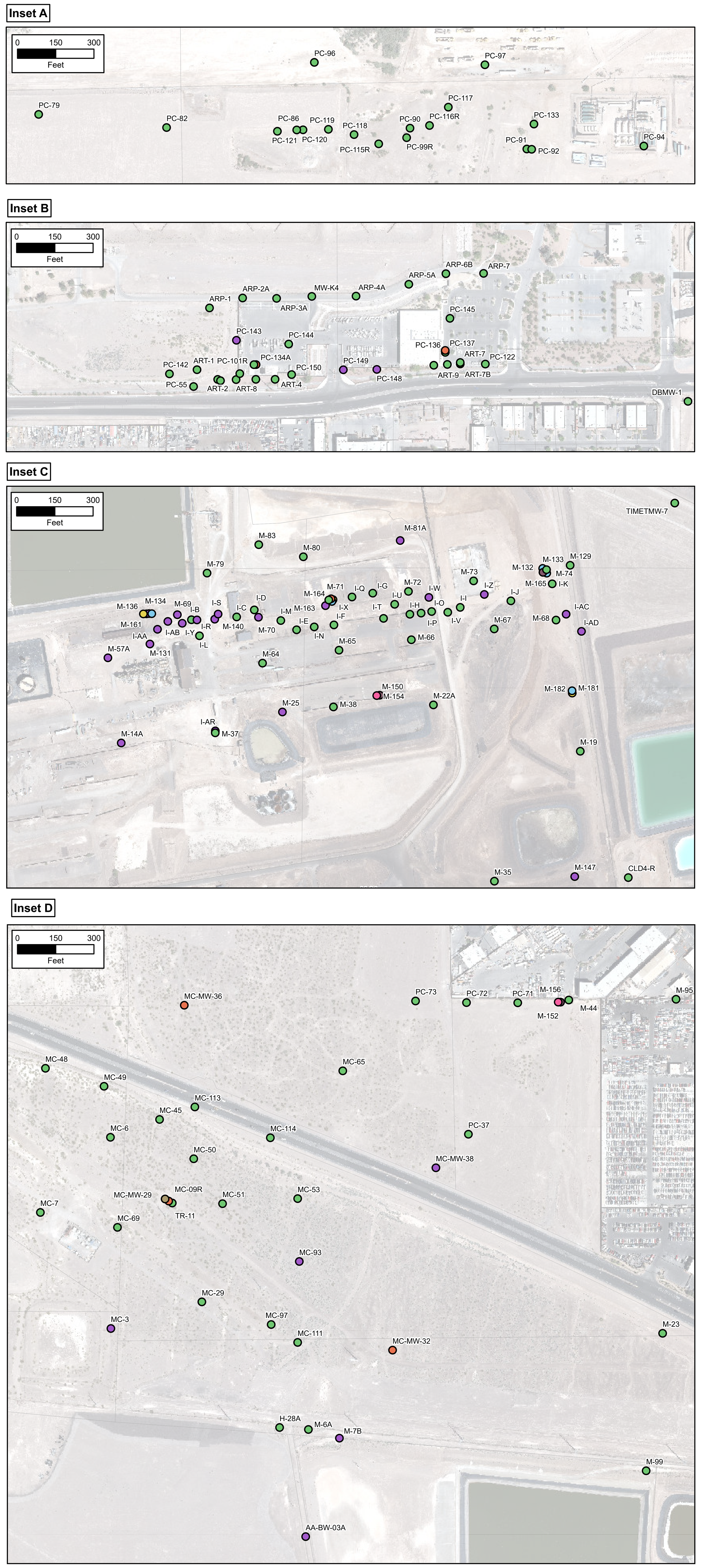


Figure 8-1

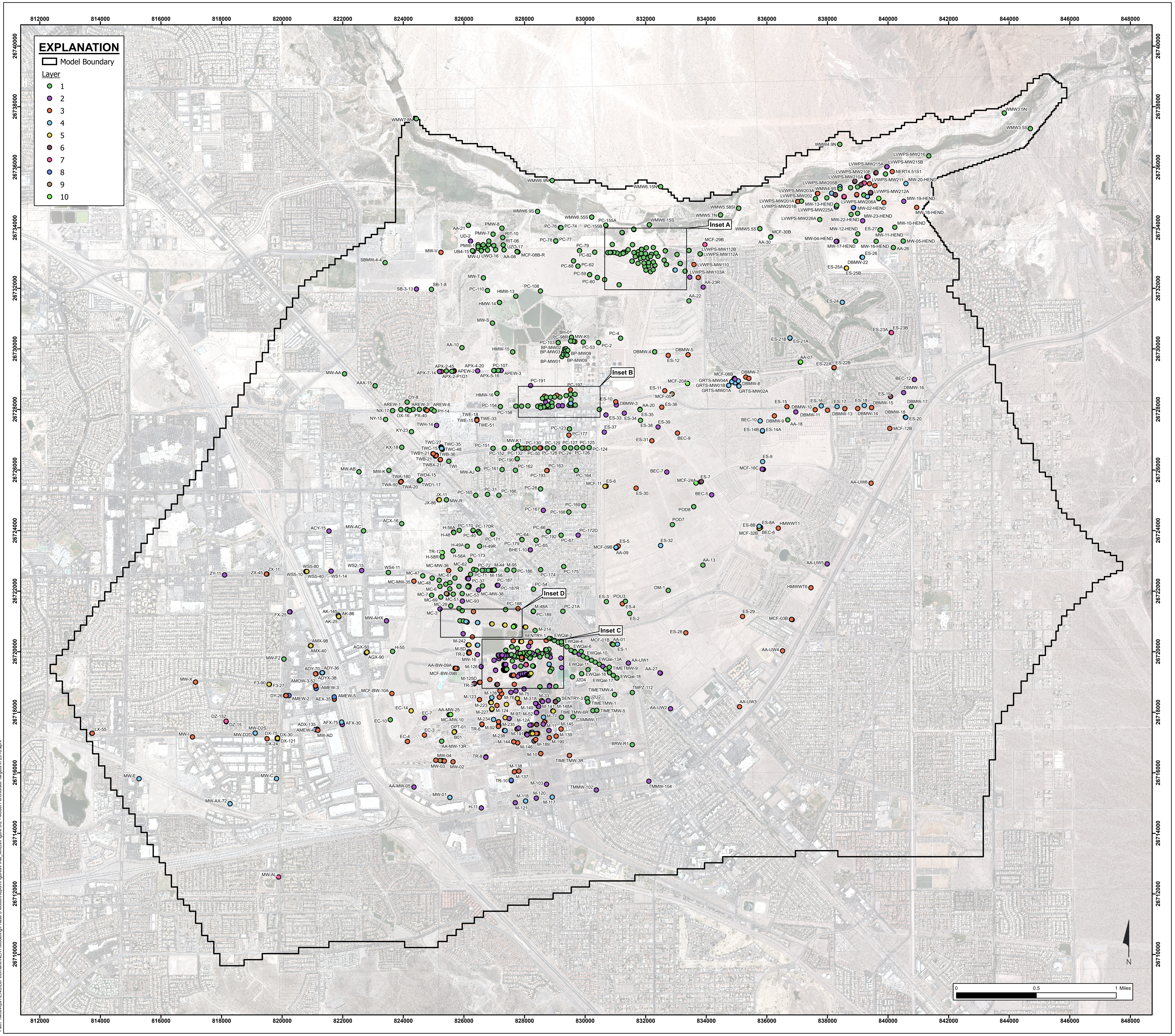
Model Perchlorate Targets in 2014

Nevada Environmental Response Trust (NERT)
Henderson, Nevada

RAMBOLL

Coordinate System: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
Projection: Transverse Mercator
Datum: North American 1983

PROJECT: 1690011200-034 | DRAFTED BY: RS | DATE: 11/22/2019



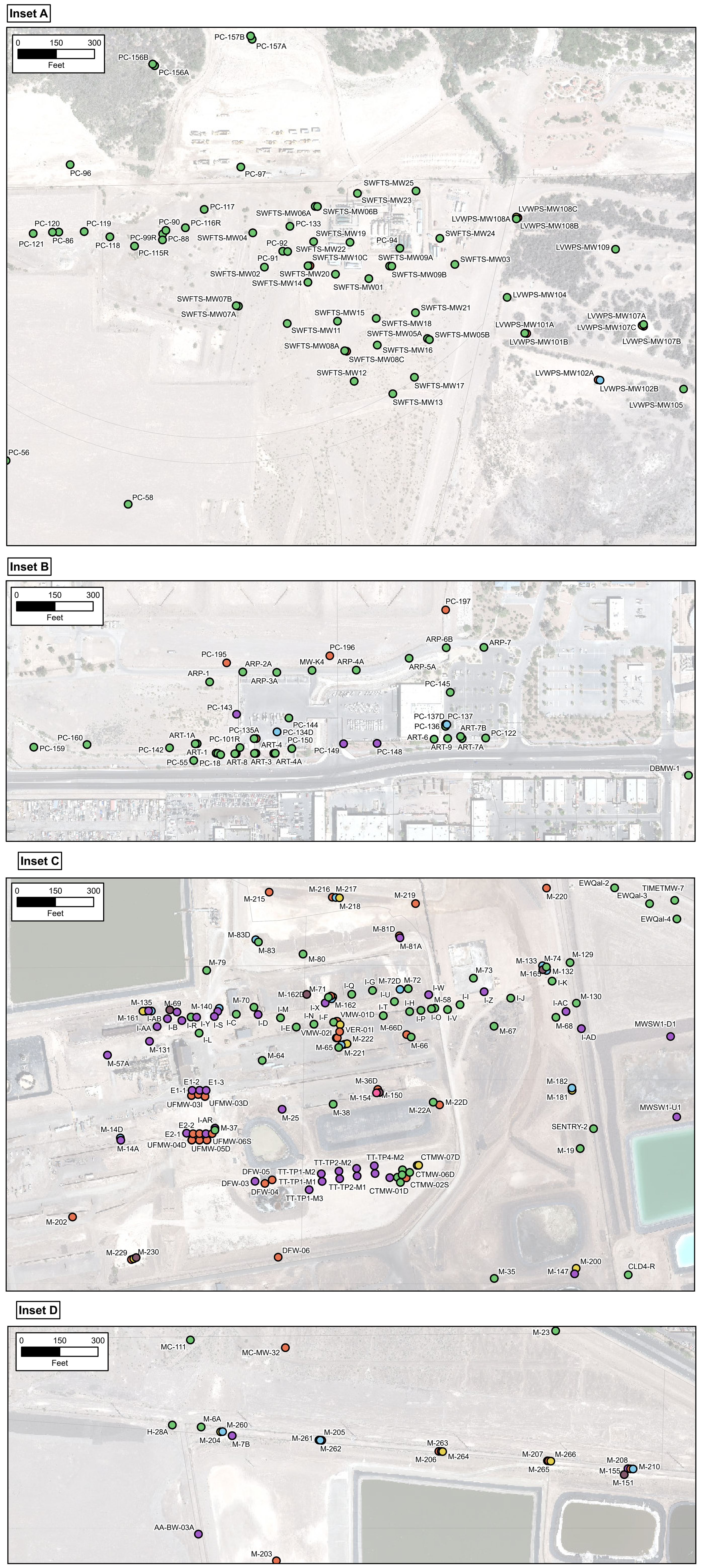


Figure 8-2

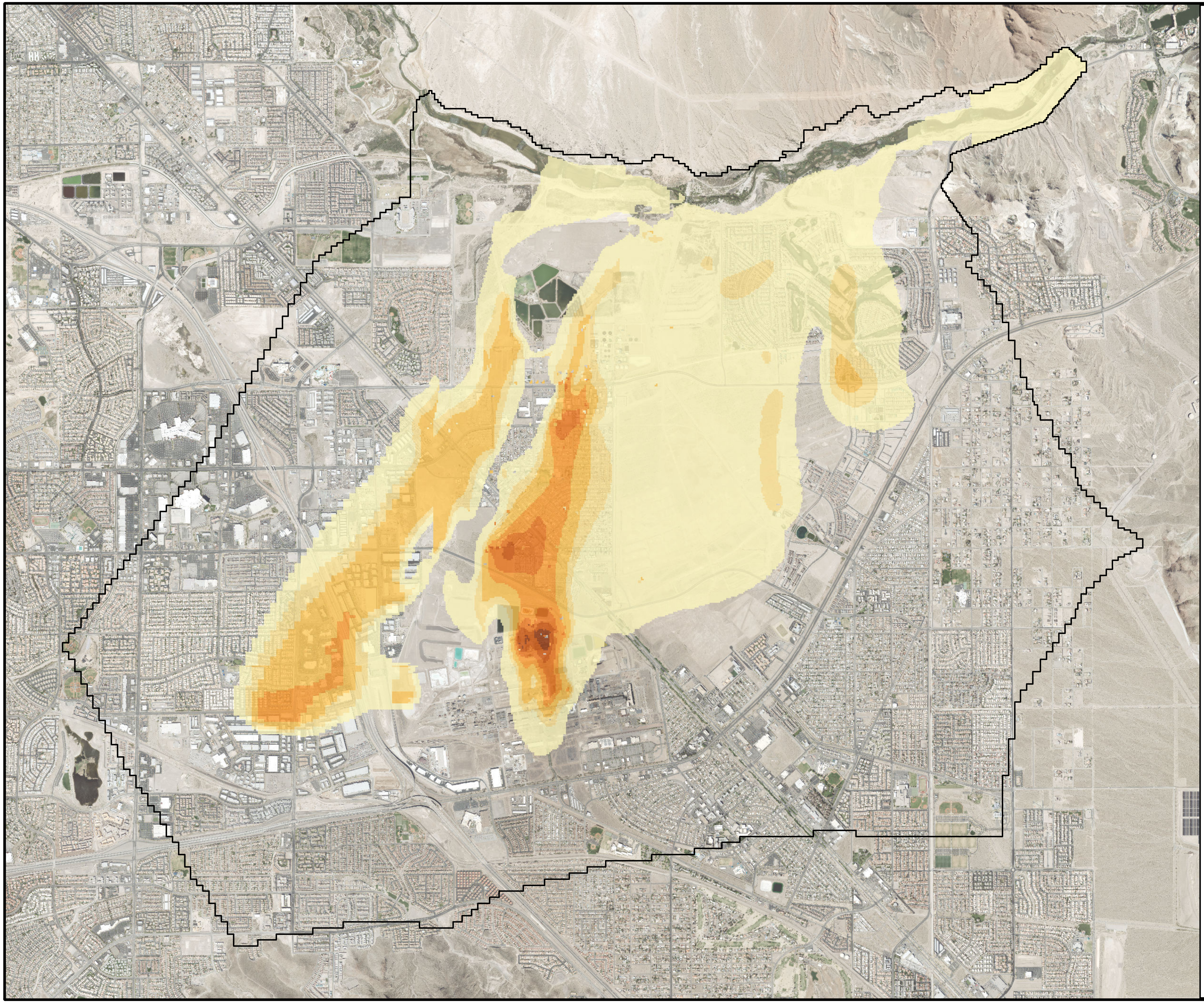
Model Perchlorate Targets in 2018

Nevada Environmental Response Trust (NERT)
Henderson, Nevada

RAMBOLL

Coordinate System: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
Projection: Transverse Mercator
Datum: North American 1983

PROJECT: 1690011200-034 | DRAFTED BY: RS | DATE: 11/22/2019



EXPLANATION

Phase 6 Model Extent

Perchlorate Concentration in mg/L

- 1-10
- 10-25
- 25-100
- 100-250
- 250-500
- 500-1000
- > 1000

Note:

mg/L = milligrams per liter

N

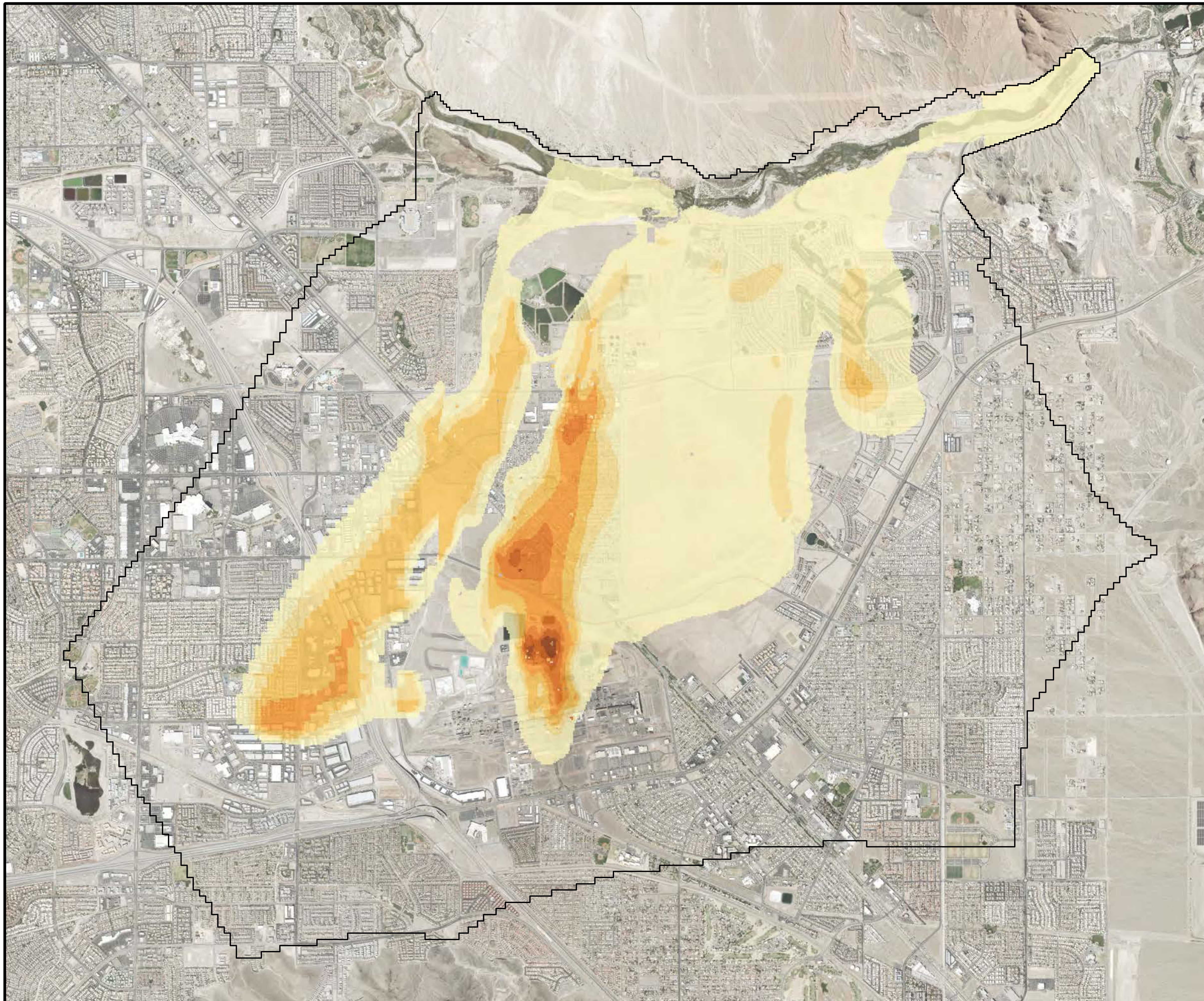
0 0.5 1 Miles

RAMBOLL

INITIAL PERCHLORATE CONCENTRATION IN LAYER 1
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/25/2019	Contract Number: 1690011200-034		Figure 8-3
Drafter: KZ	Approved:	Revised:	

\\wcevlfps1\ENG\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 8-3 - Initial Perchlorate Concentrations in Layer 1_v2.mxd



EXPLANATION

Phase 6 Model Extent

Perchlorate Concentration in mg/L

- 1-10
- 10-25
- 25-100
- 100-250
- 250-500
- 500-1000
- > 1000

Note:

mg/L = milligrams per liter

N

0 0.5 1 Miles

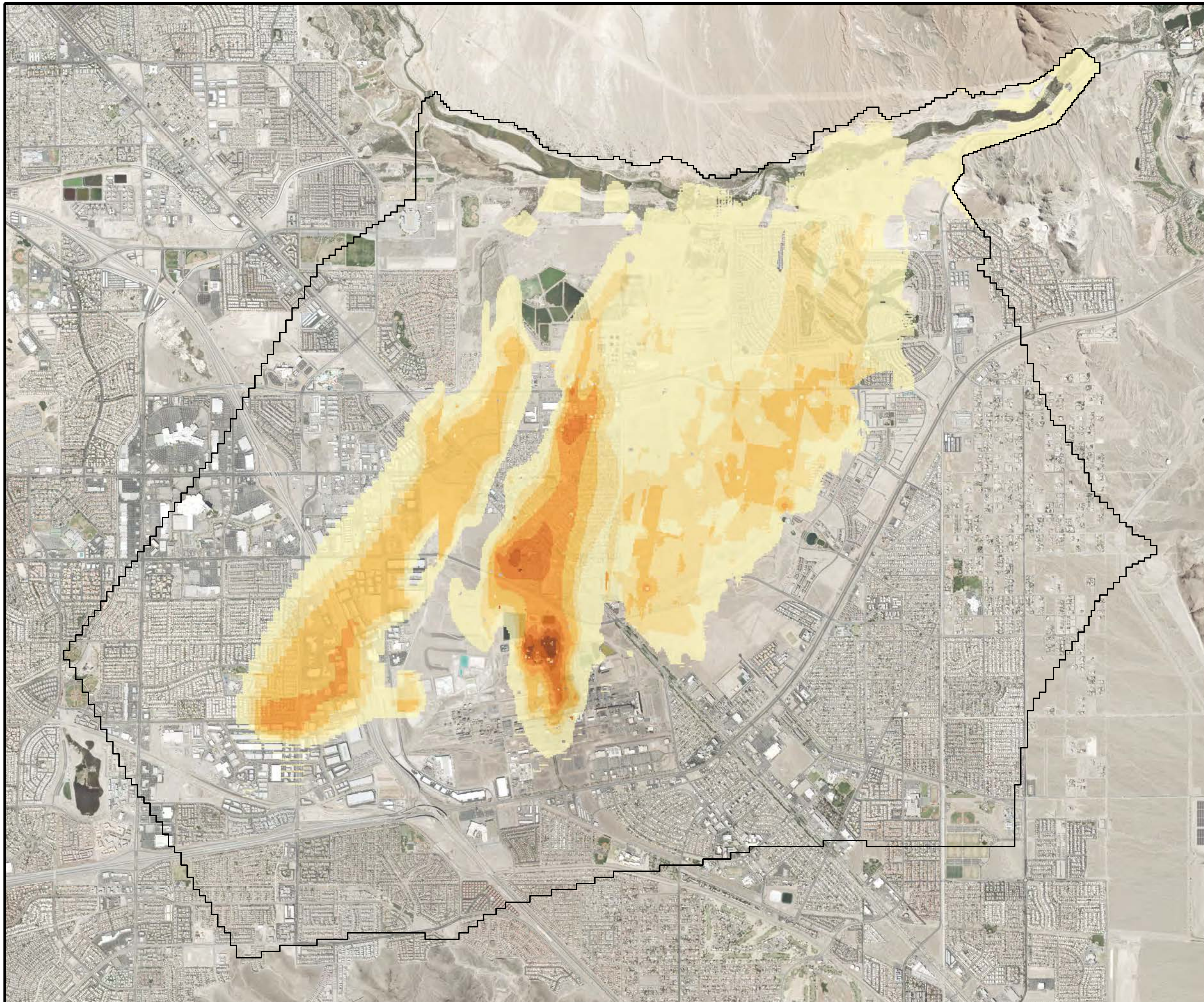
RAMBOLL

INITIAL PERCHLORATE CONCENTRATION IN LAYER 2

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: KZ	Approved:	Revised:	8-4

H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 8-4 - Initial Perchlorate Concentrations in Layer 2.mxd



EXPLANATION

Phase 6 Model Extent

Perchlorate Concentration in mg/L

- 1-10
- 10-25
- 25-100
- 100-250
- 250-500
- 500-1000
- > 1000

Note:

mg/L = milligrams per liter

N

0 0.5 1 Miles

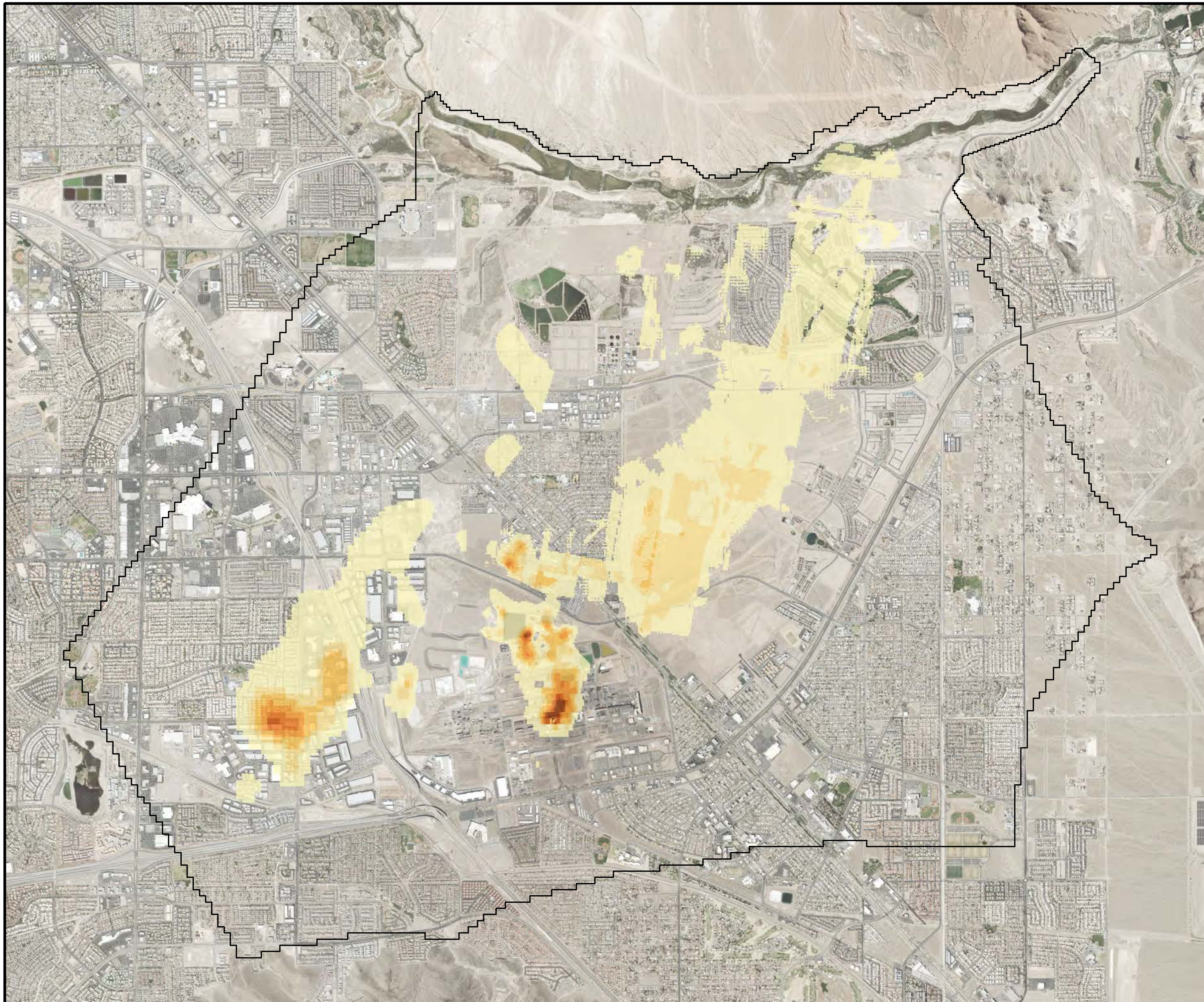
RAMBOLL

INITIAL PERCHLORATE CONCENTRATION IN LAYER 3

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: KZ	Approved:	Revised:	8-5

H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 8-5 - Initial Perchlorate Concentrations in Layer 3.mxd



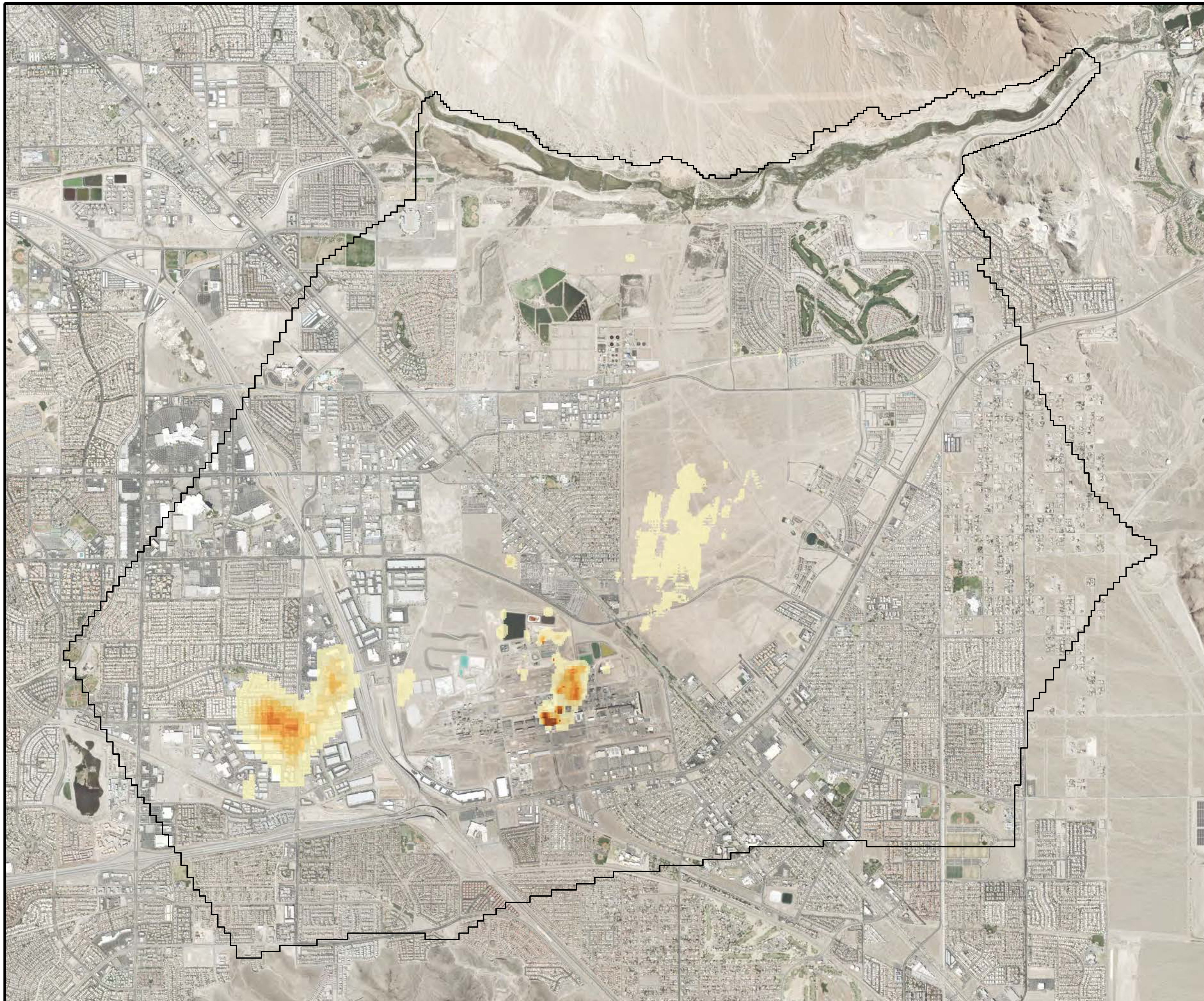
H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 8-6 - Initial Perchlorate Concentrations in Layer 4.mxd

RAMBOLL

INITIAL PERCHLORATE CONCENTRATION IN LAYER 4

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 8-6
Drafter: KZ	Approved:	Revised:	



EXPLANATION

Phase 6 Model Extent

Perchlorate Concentration in mg/L

- 1-10
- 10-25
- 25-100
- 100-250
- 250-500
- 500-1000
- > 1000

Note:

mg/L = milligrams per liter

N

0 0.5 1 Miles

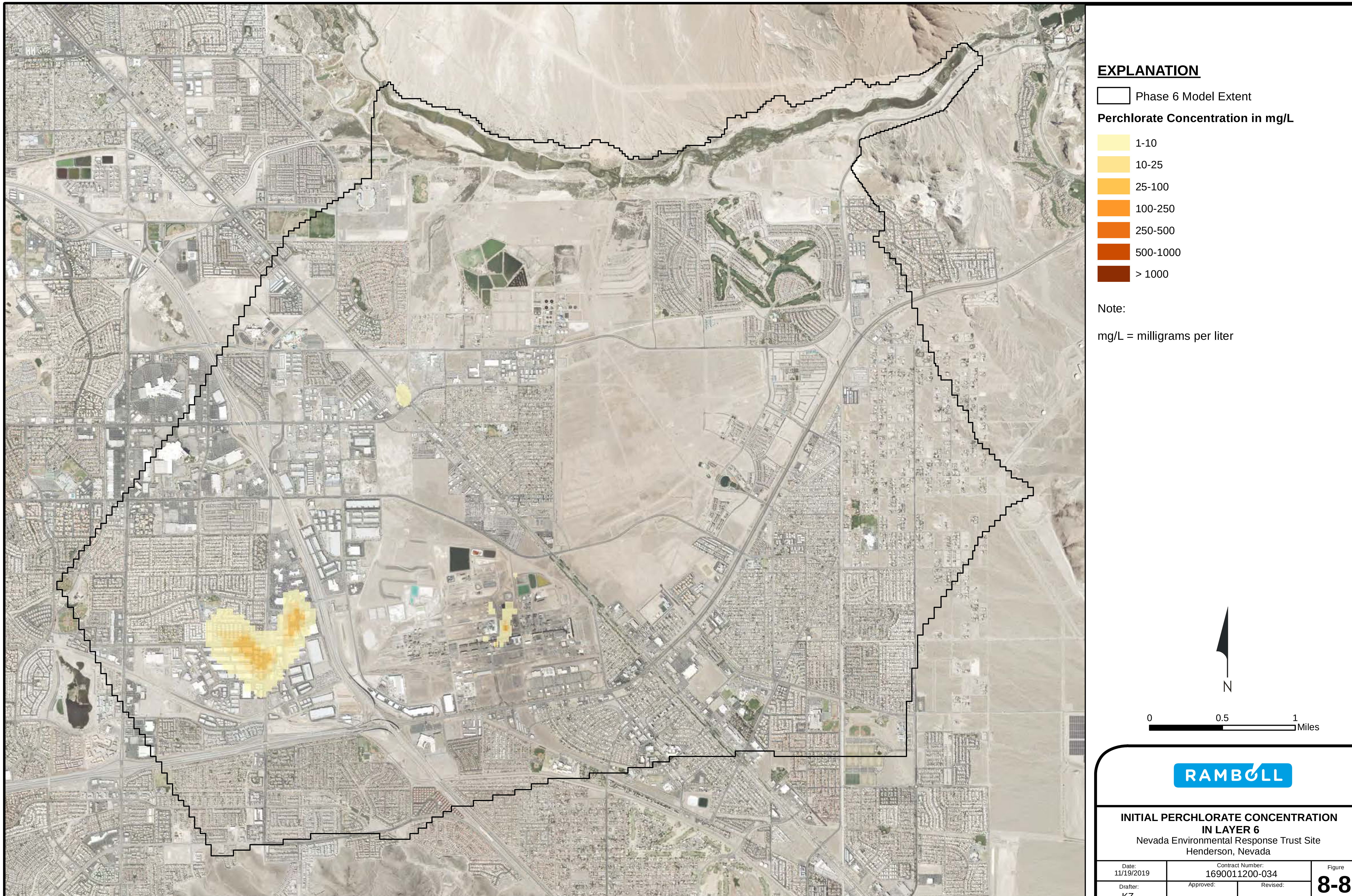
RAMBOLL

INITIAL PERCHLORATE CONCENTRATION IN LAYER 5

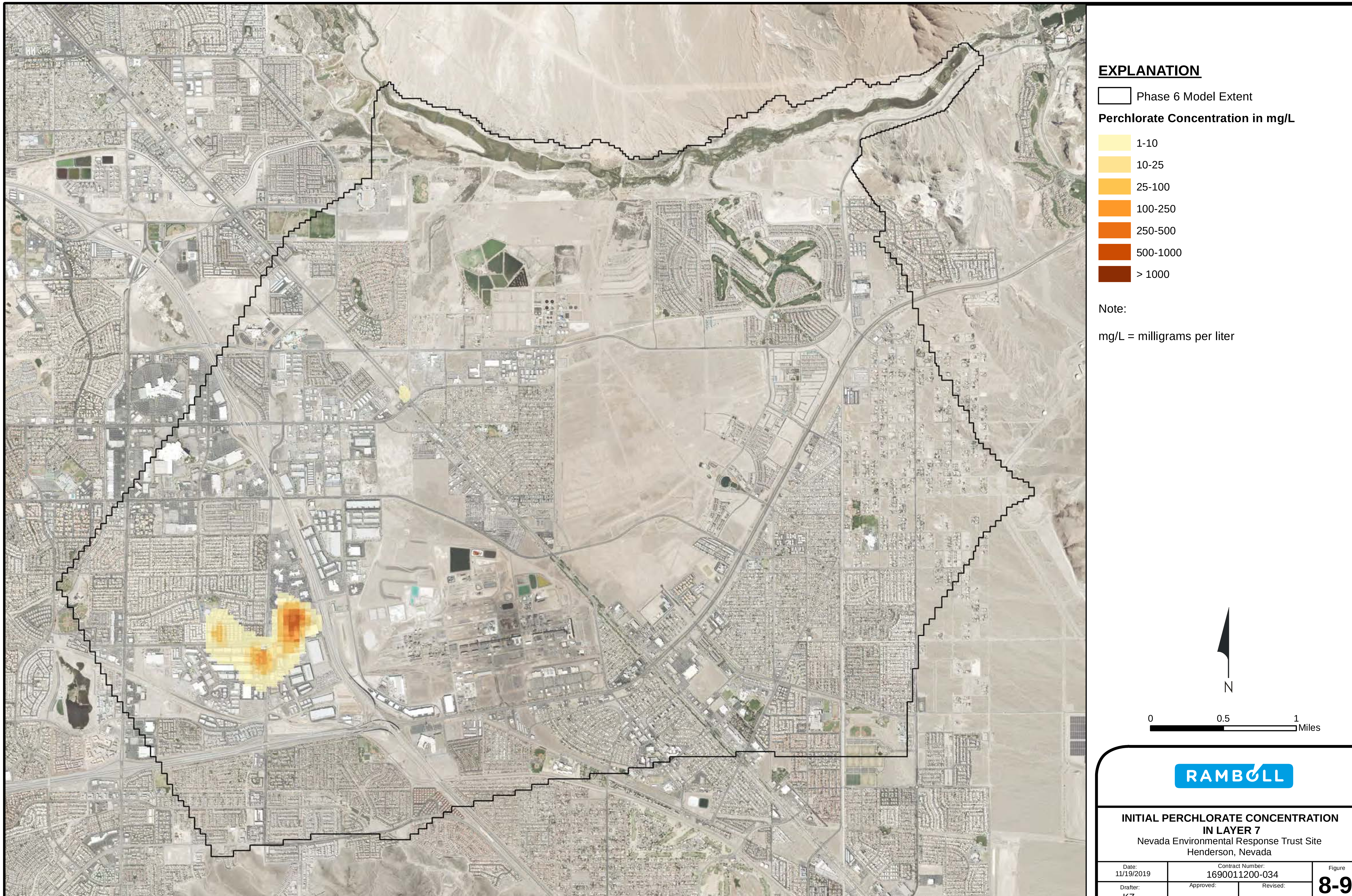
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: KZ	Approved:	Revised:	**8-7**

H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 8-7 - Initial Perchlorate Concentrations in Layer 5.mxd



EXPLANATION
Phase 6 Model Extent
Perchlorate Concentration in mg/L
1-10
10-25
25-100
100-250
250-500
500-1000
> 1000
Note:
mg/L = milligrams per liter
N
0
0.5
1
Miles
RAMBOLL
INITIAL PERCHLORATE CONCENTRATION IN LAYER 6
Nevada Environmental Response Trust Site
Henderson, Nevada
Date: 11/19/2019
Contract Number: 1690011200-034
Figure 8-8
Drafter: KZ
Approved:
Revised:
H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 8-8 - Initial Perchlorate Concentrations in Layer 6.mxd

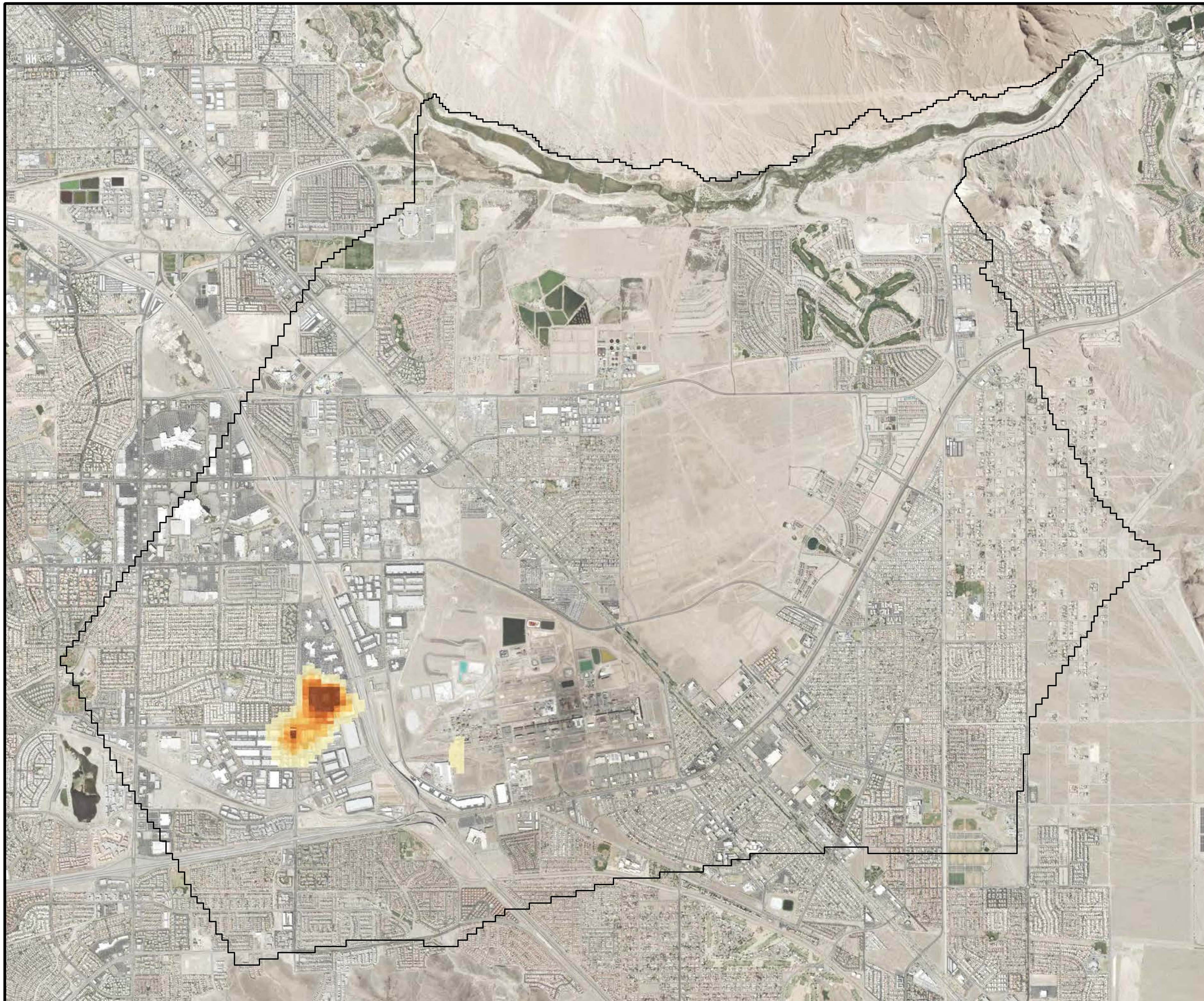


RAMBOLL

INITIAL PERCHLORATE CONCENTRATION IN LAYER 7
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure 8-9
Drafter: KZ	Approved:	Revised:	

H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 8-9 - Initial Perchlorate Concentrations in Layer 7.mxd



EXPLANATION

Phase 6 Model Extent

Perchlorate Concentration in mg/L

- 1-10
- 10-25
- 25-100
- 100-250
- 250-500
- 500-1000
- > 1000

Note:

mg/L = milligrams per liter

N

0 0.5 1 Miles

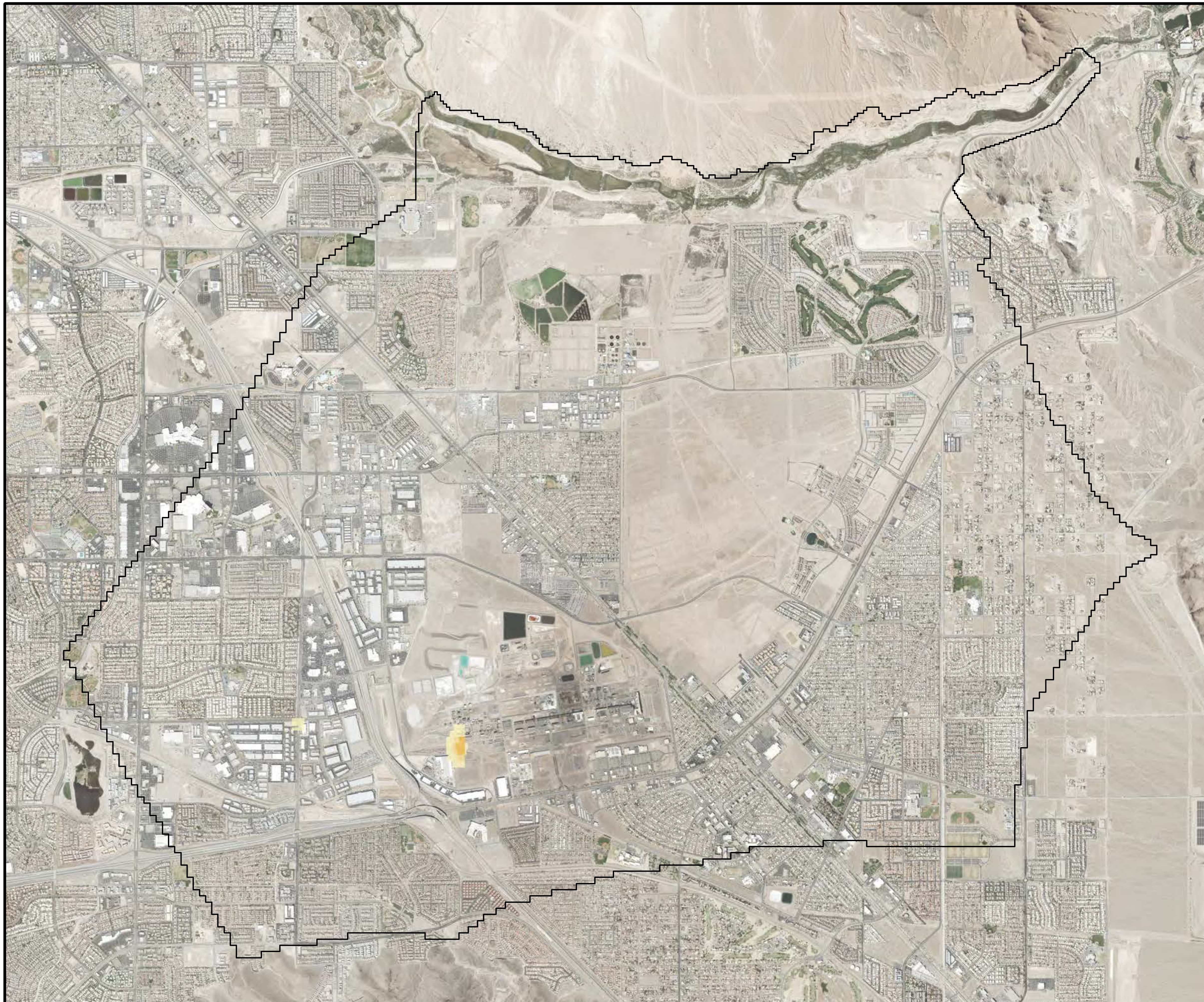
RAMBOLL

INITIAL PERCHLORATE CONCENTRATION IN LAYER 8

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: KZ	Approved:	Revised:	8-10

H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 8-10 - Initial Perchlorate Concentrations in Layer 8.mxd



EXPLANATION

Phase 6 Model Extent

Perchlorate Concentration in mg/L

- 1-10
- 10-25
- 25-100
- 100-250
- 250-500
- 500-1000
- > 1000

Note:

mg/L = milligrams per liter

N

0 0.5 1 Miles

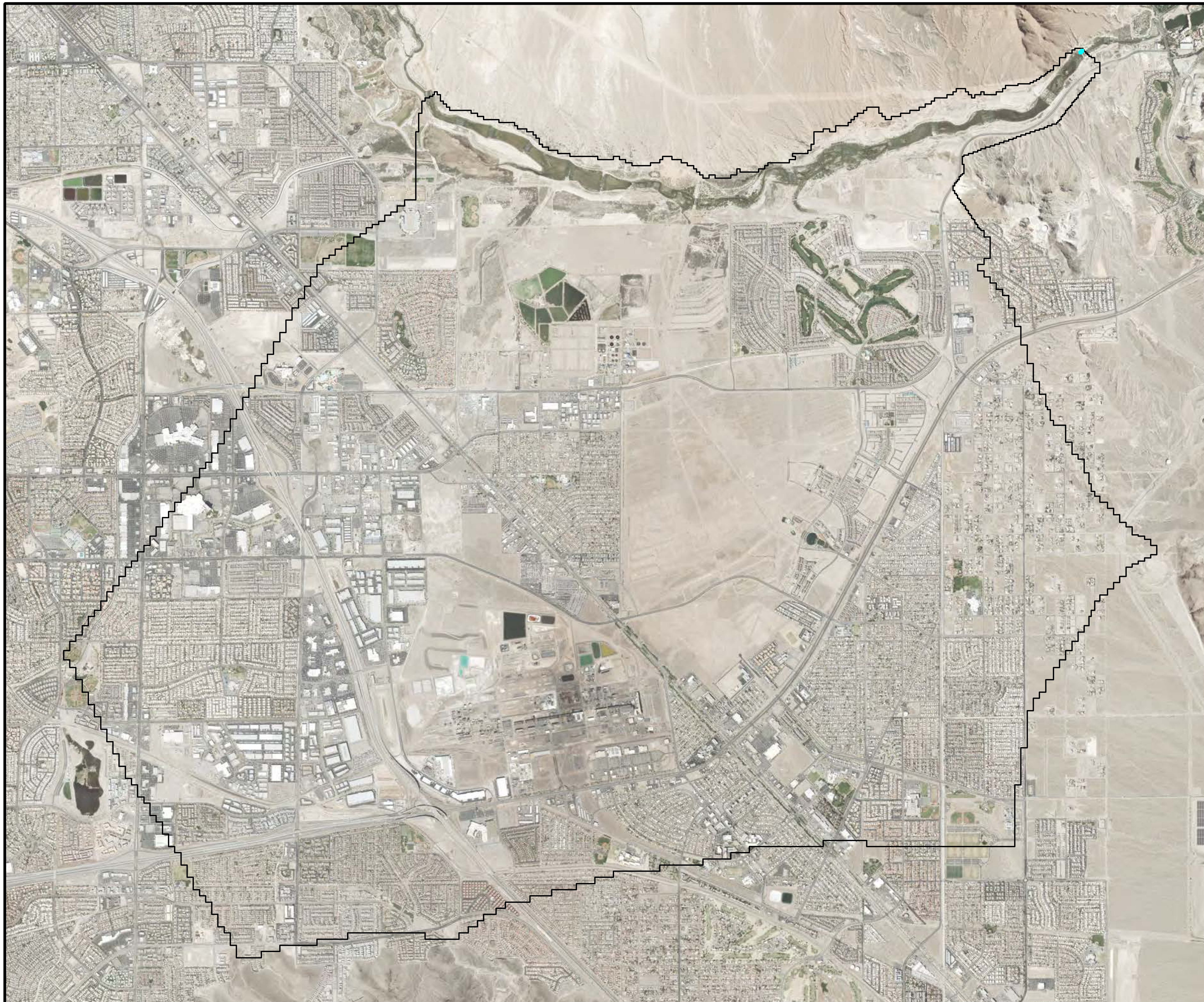
RAMBOLL

INITIAL PERCHLORATE CONCENTRATION IN LAYER 9

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: KZ	Approved:	Revised:	**8-11**

H:\LePetomane\NERT\Modeling\Phase 6 Model\Report\Figures\Final_MXDs\Figure 8-11 - Initial Perchlorate Concentrations in Layer 9.mxd



EXPLANATION

Phase 6 Model Extent

Perchlorate Concentration in mg/L

- 1-10
- 10-25
- 25-100
- 100-250
- 250-500
- 500-1000
- > 1000

Note:

mg/L = milligrams per liter

Perchlorate concentrations in Layer 10 of the model are below 1 mg/L.

N

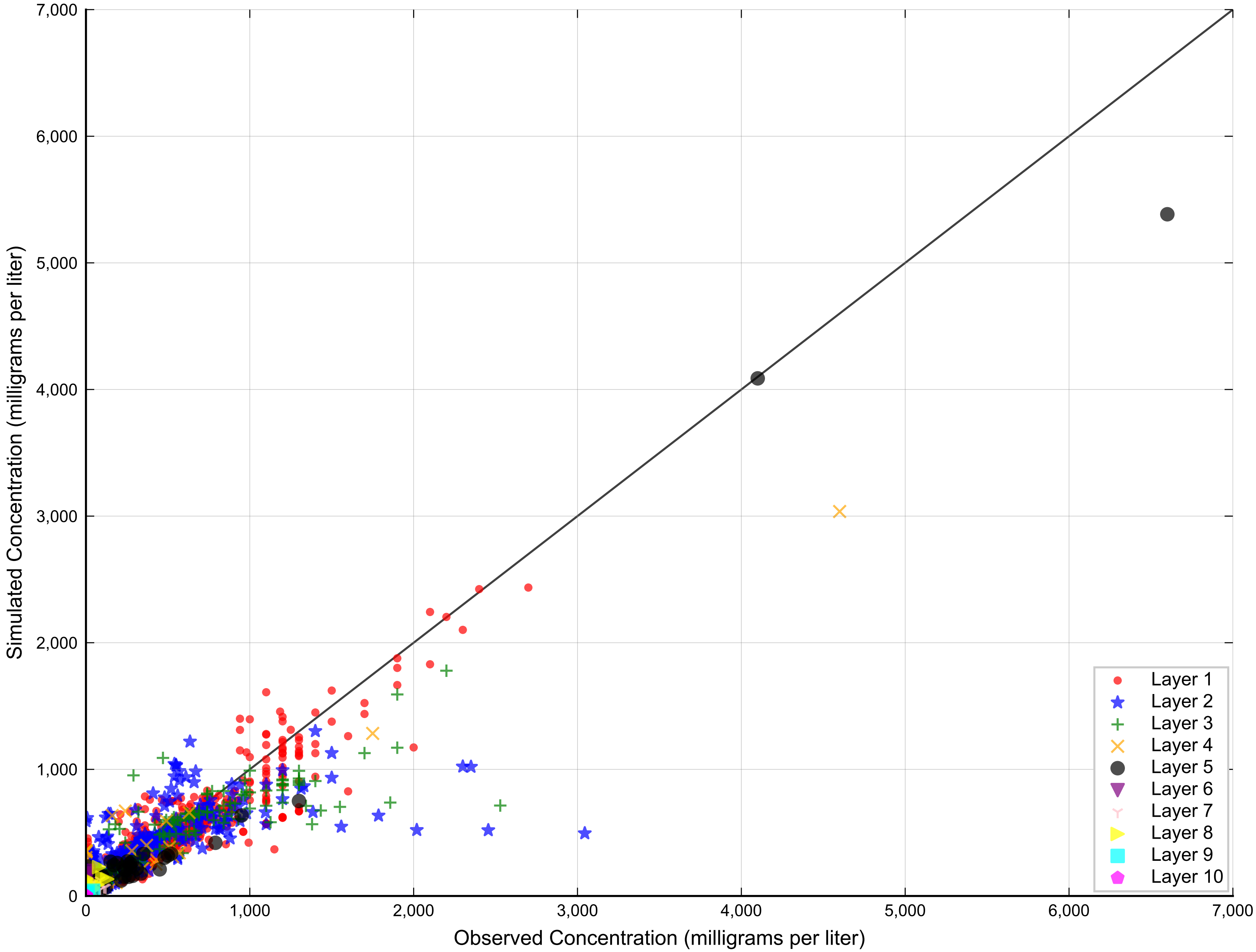
0 0.5 1 Miles

RAMBOLL

INITIAL PERCHLORATE CONCENTRATION IN LAYER 10

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure
Drafter: KZ	Approved:	Revised:	8-12



RAMBOLL

Observed versus Simulated Perchlorate Concentrations
Nevada Environmental Response Trust Site
Henderson Nevada

Figure
9-1

Drafter: KZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:

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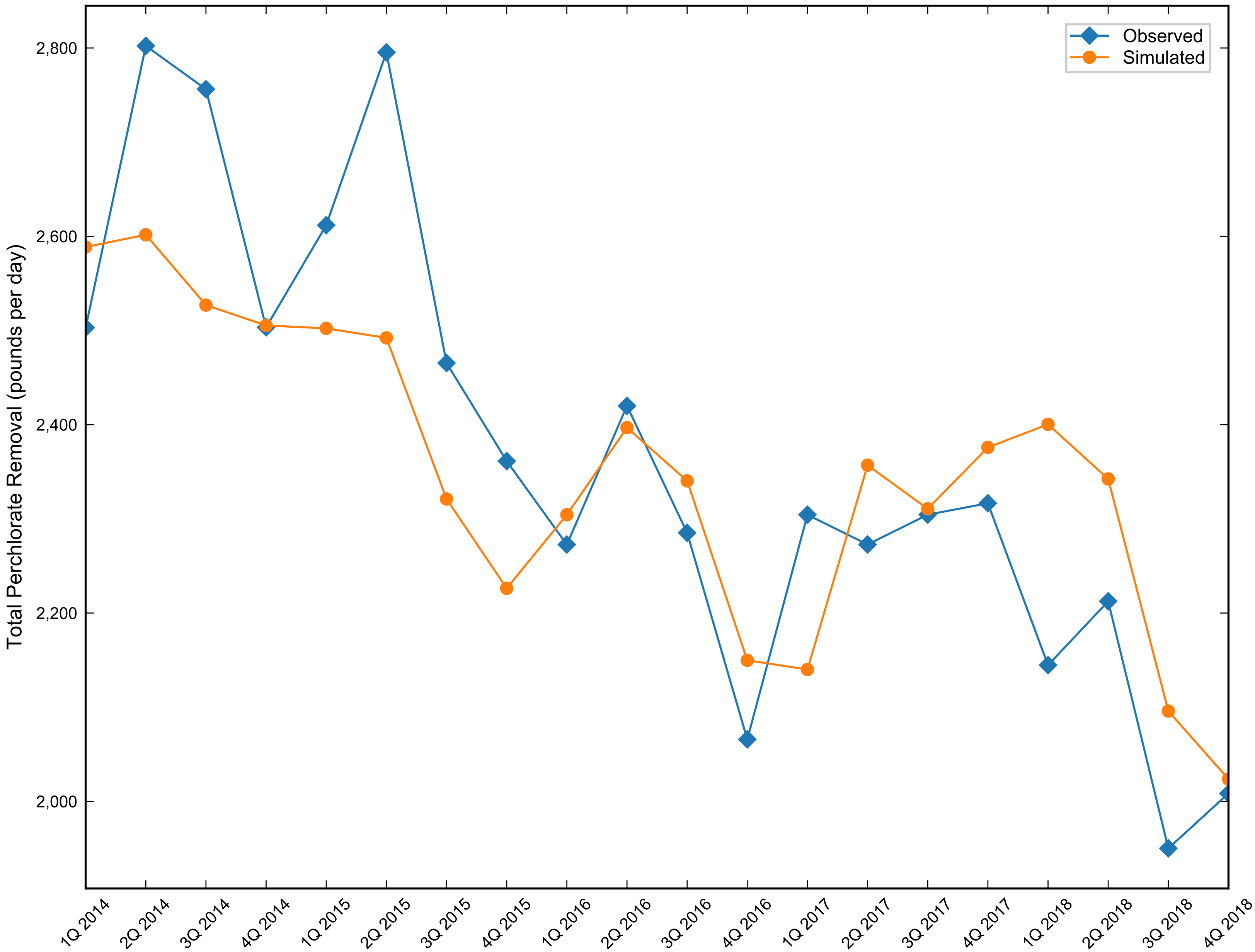
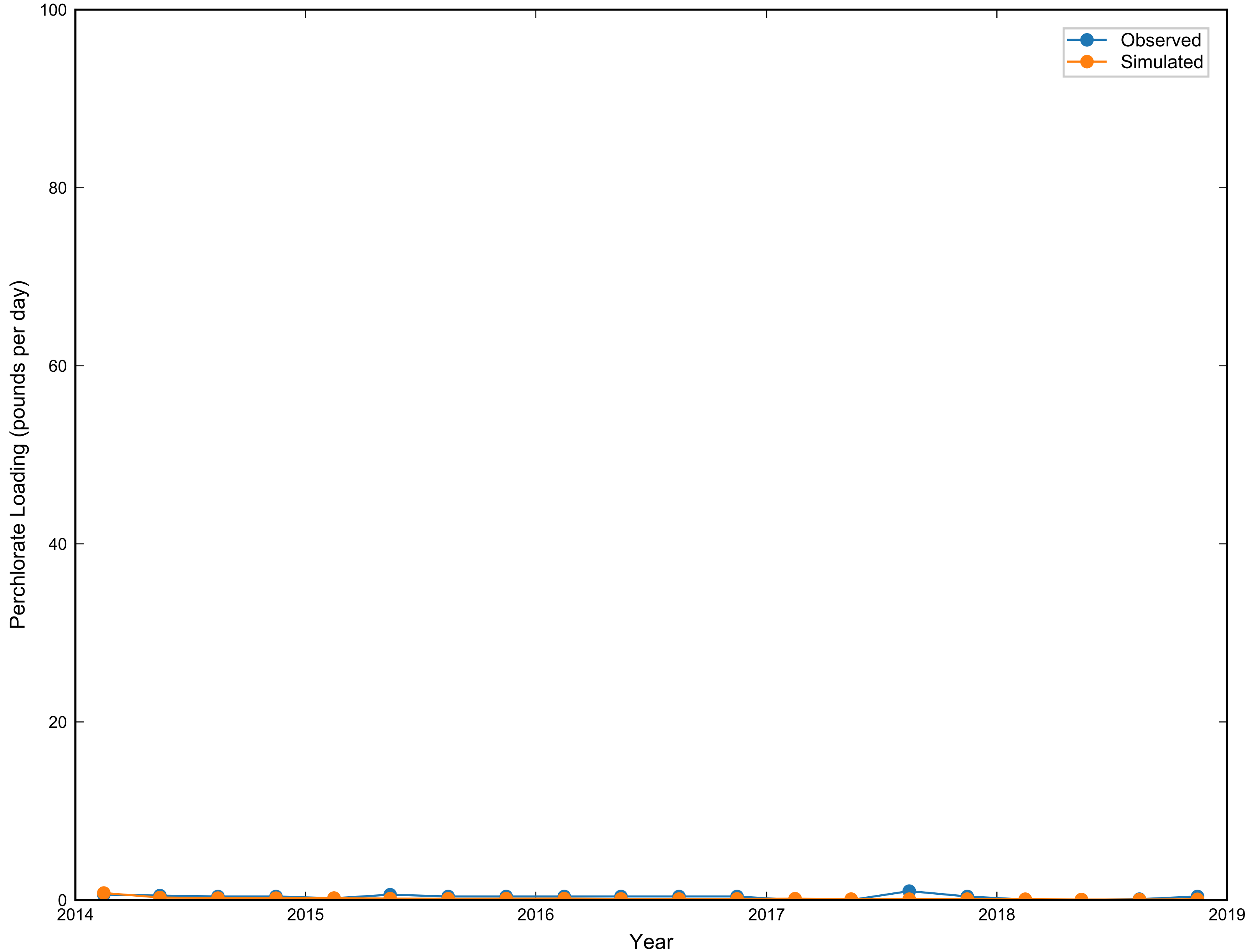


RAMBOLL

Observed versus Simulated Perchlorate Removal (2014-2018)
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
9-2

Drafter: MFS | Date: 11/22/19 | Contract Number: 1690011200-034 | Approved: | Revised:



RAMBOLL

Observed versus Simulated Perchlorate Loading at Duck Creek Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
9-3

Drafter: RZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:

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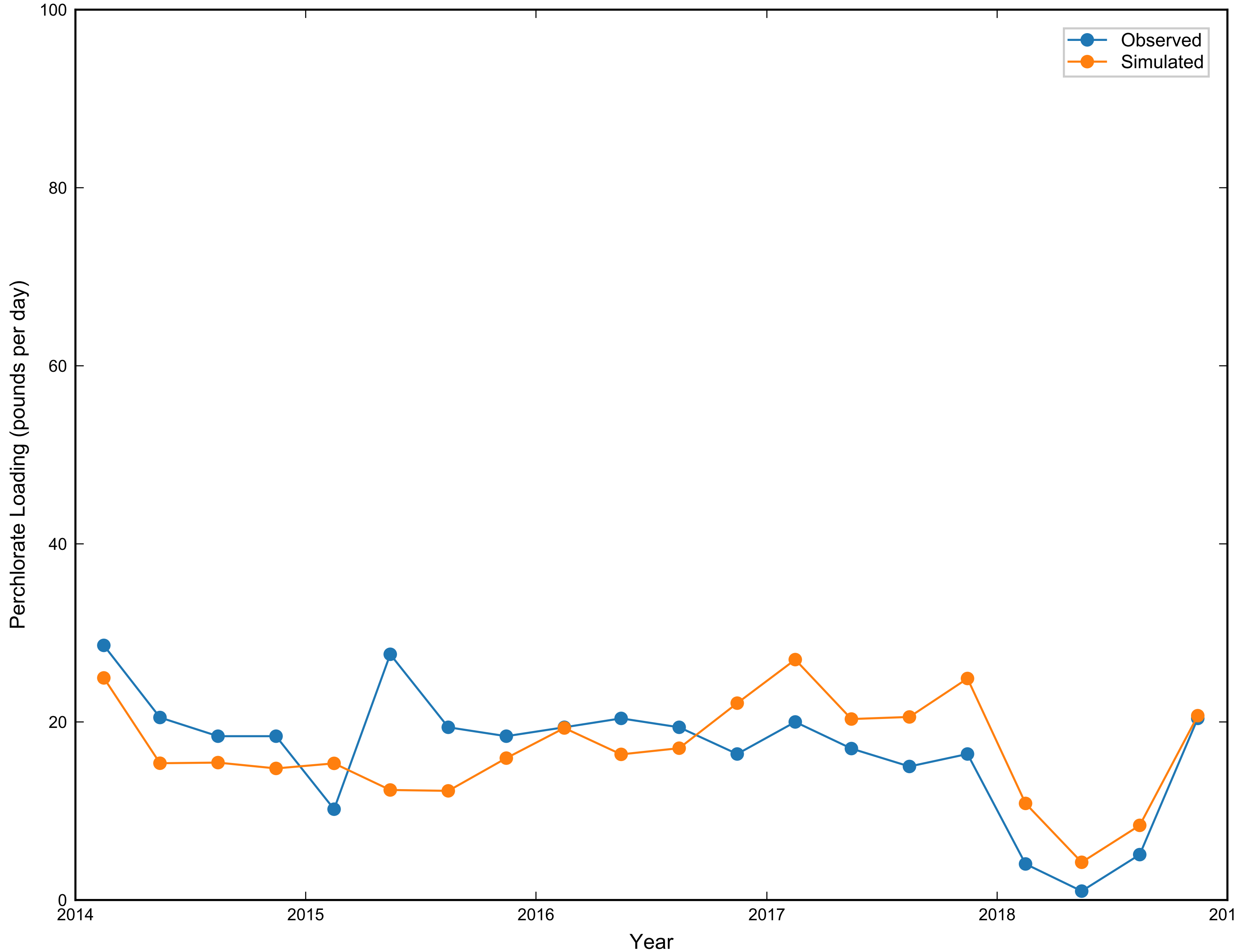
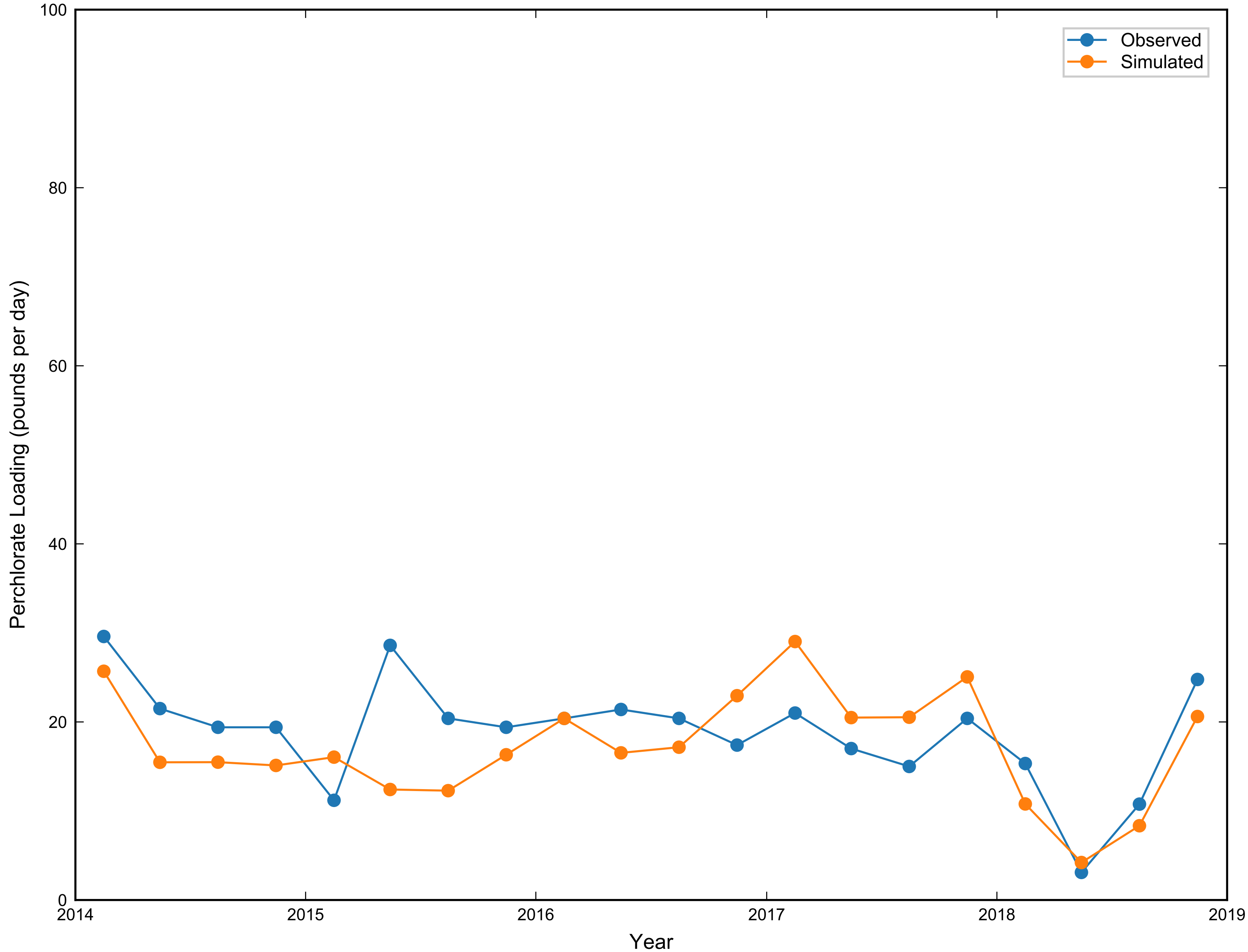


RAMBOLL

Observed versus Simulated Perchlorate Loading at Pabco Road Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure **9-4**

Drafter: RZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:

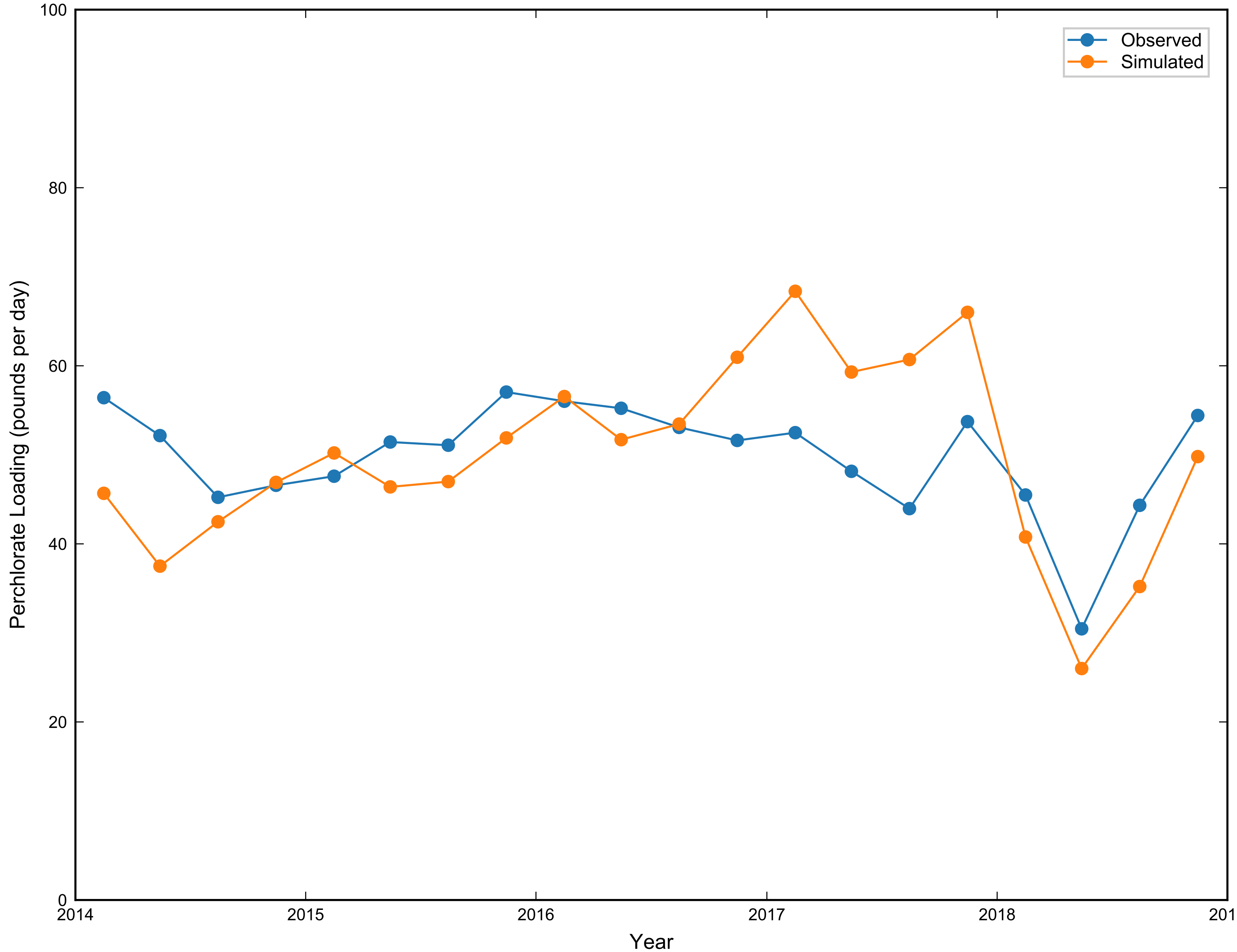


RAMBOLL

Observed versus Simulated Perchlorate Loading at Bostic Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
9-5

Drafter: RZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:



Observed versus Simulated Perchlorate Loading at Homestead Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure **9-6**

Drafter: RZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:

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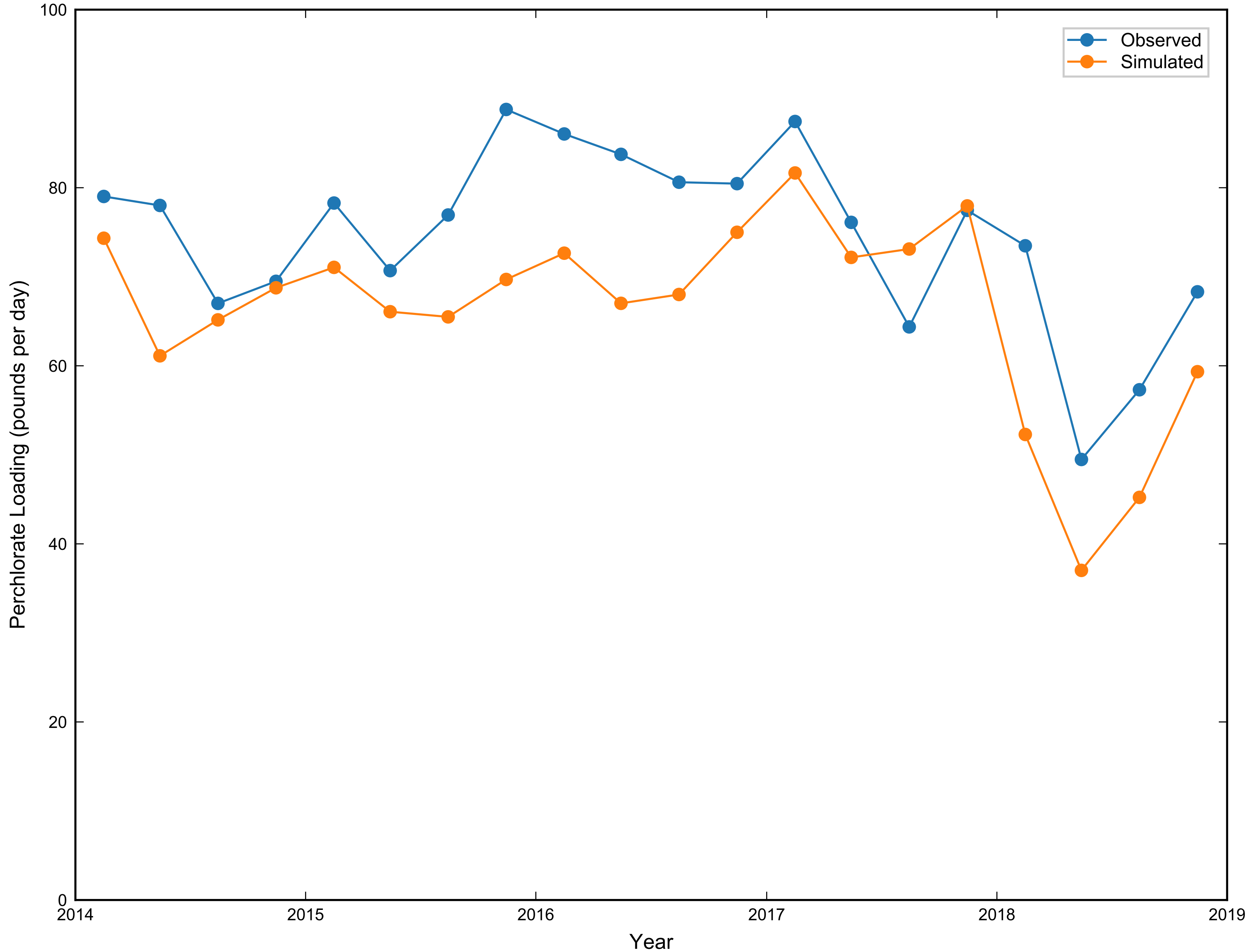
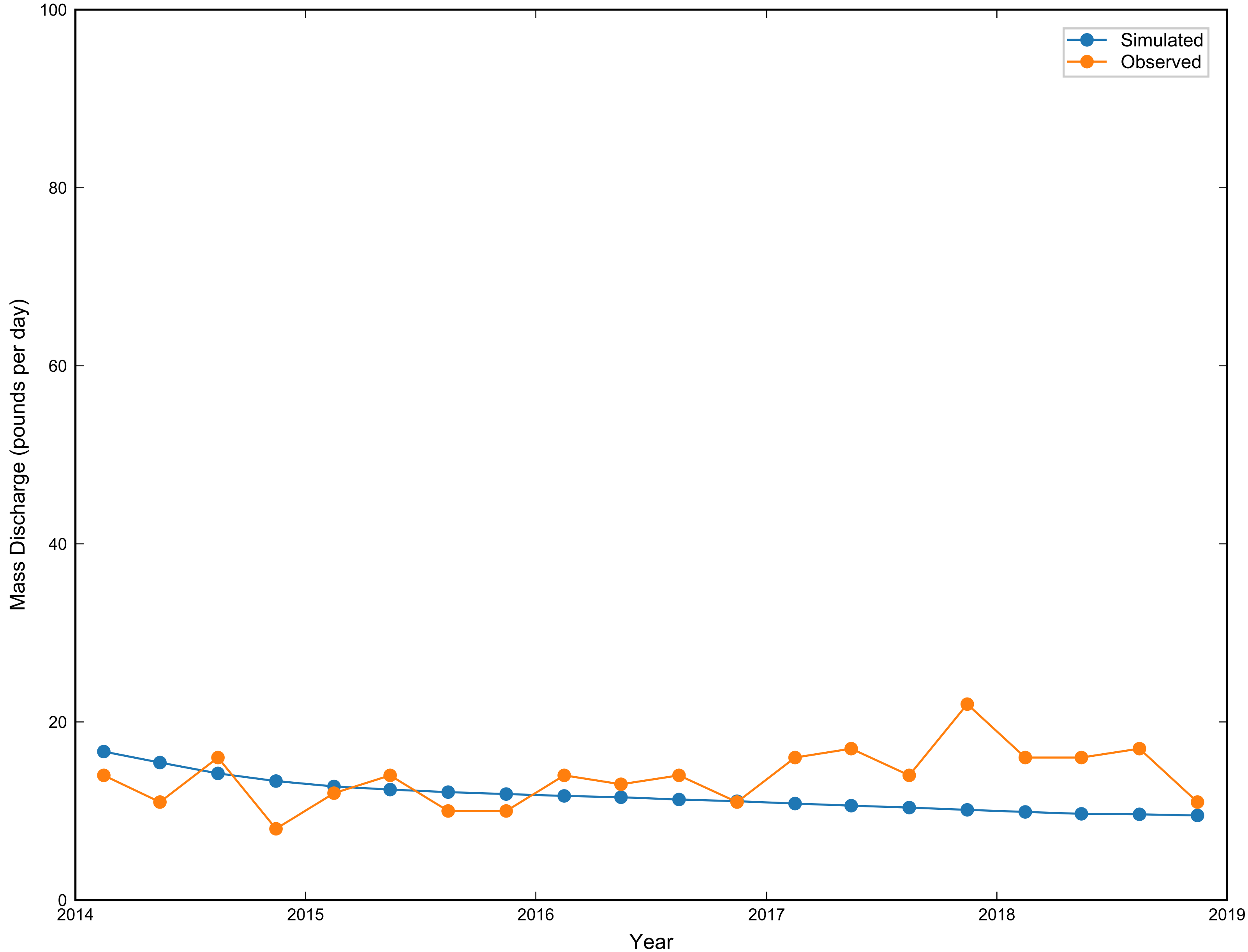


Observed versus Simulated Perchlorate Loading at Three Kids Gage Station
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
9-7

Drafter: RZ | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:



Observed versus Simulated Perchlorate Discharge in Athens Drainage Channel
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
9-8

Drafter: RZ	Date: 11/21/19	Contract Number: 1690011200-034	Approved:	Revised:

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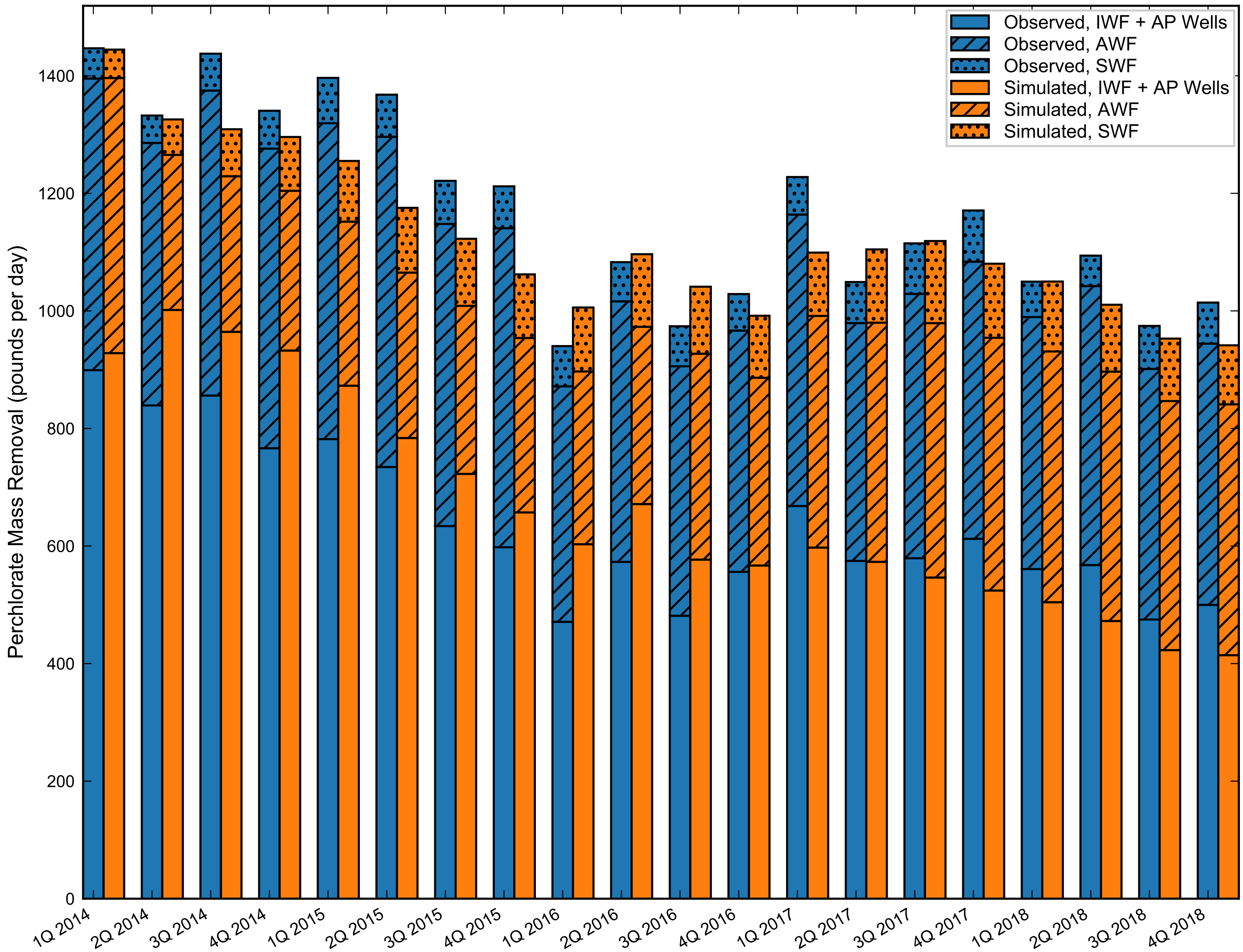

RAMBOLL

Observed versus Simulated Perchlorate Mass Removal at NERT Well Fields
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
9-9

Drafter: CT | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:

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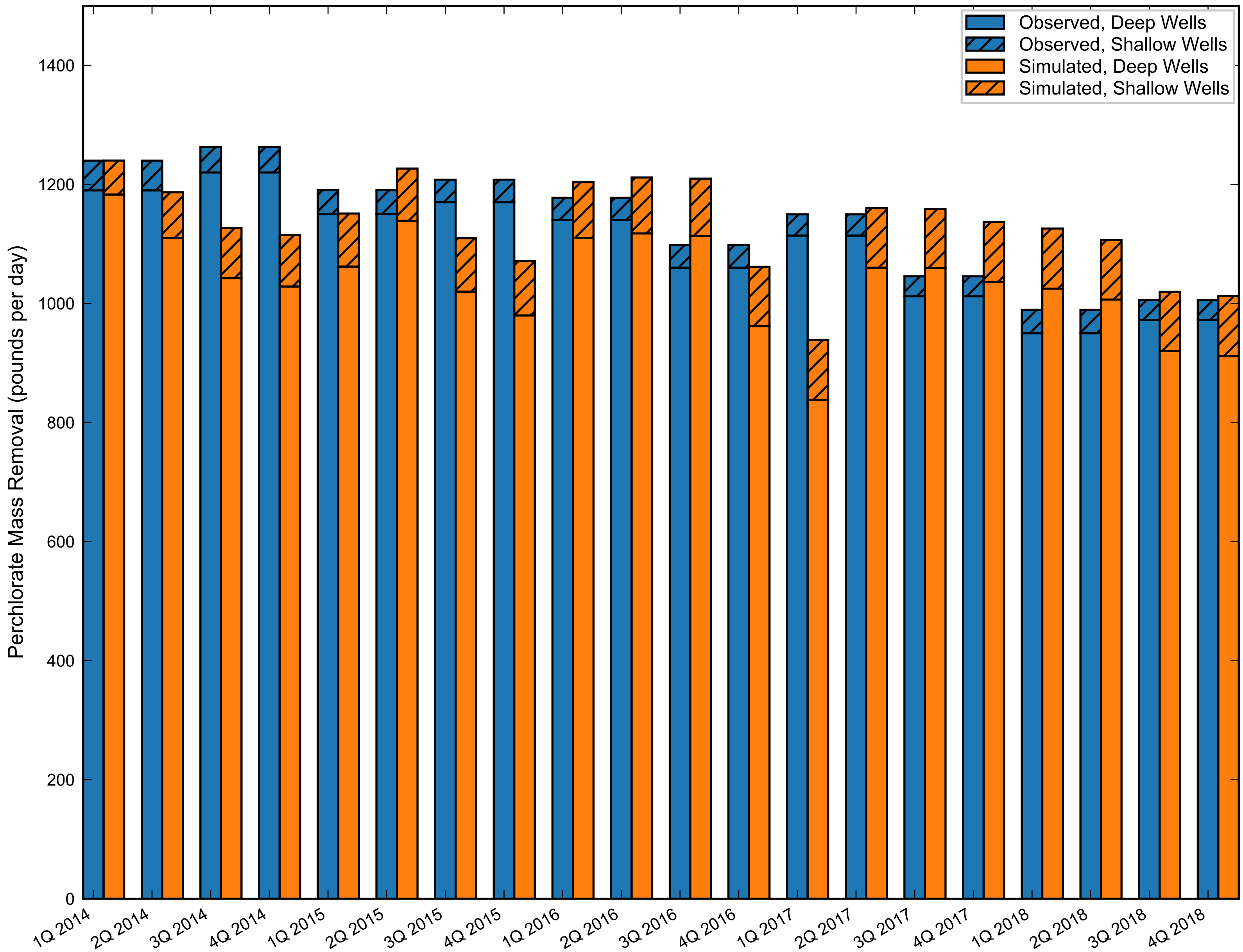
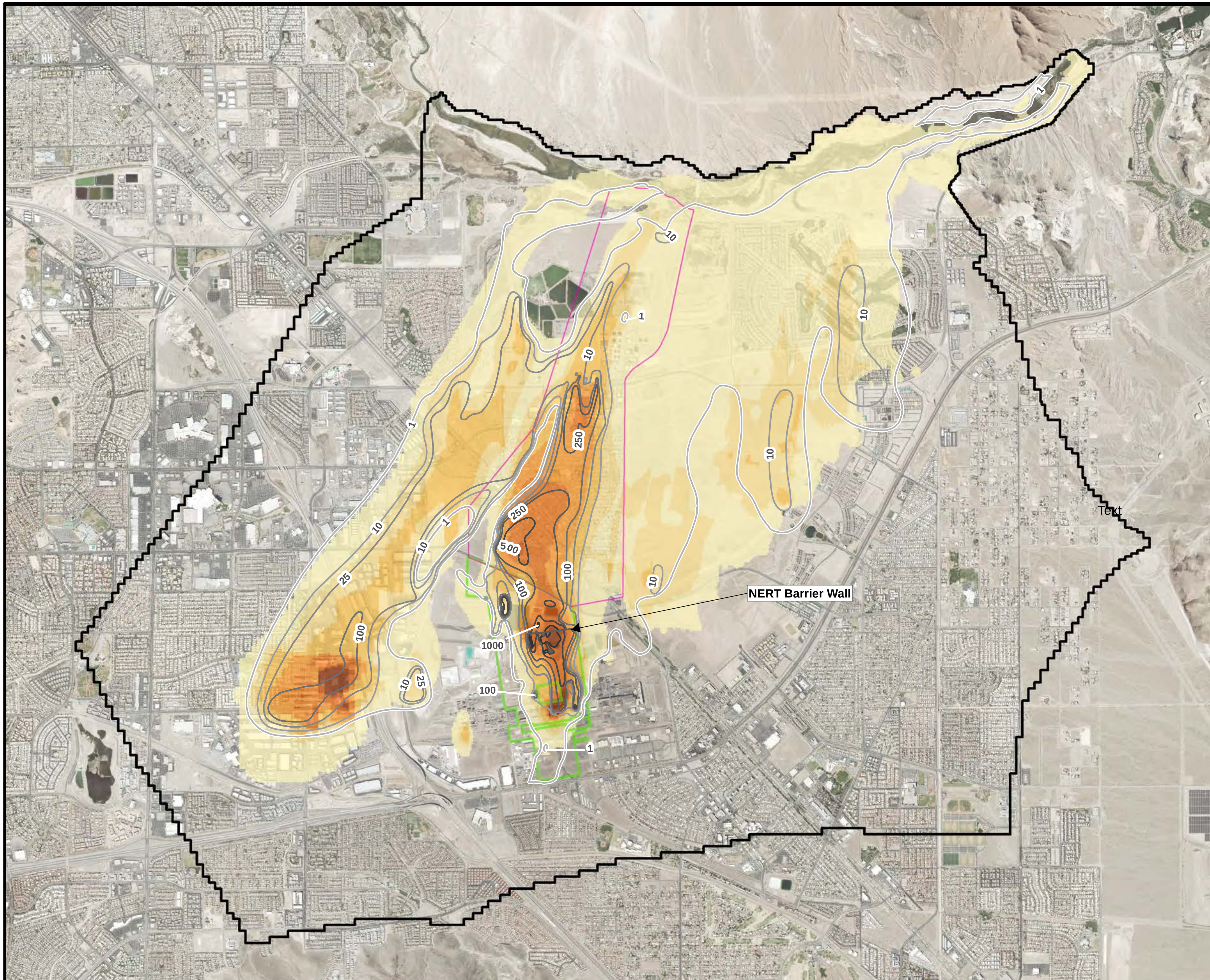


RAMBOLL

Observed versus Simulated Perchlorate Mass Removal at AMPAC/Endeavour Well Field
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
9-10

Drafter: CT | Date: 11/21/19 | Contract Number: 1690011200-034 | Approved: | Revised:



EXPLANATION

- Off-site NERT RI Study Area
- NERT Property Boundary
- Phase 6 Model Boundary

Simulated Perchlorate Plume

- < 1 mg/L
- 1-10
- 10-25
- 25-100
- 100-250
- 250-500
- 500-1,000
- >1,000 mg/L

Observed 2018 Plume Contours*

- 1 mg/L (lines darken as values increase)

*Ramboll. 2018. Annual Remedial Performance Report for Chromium and Perchlorate, Nevada Environmental Response Trust Site; Henderson, Nevada; July 2017-June 2018. November 9.

Note:

mg/L = milligrams per liter

N

0 0.5 1 Miles

RAMBOLL

Simulated versus Observed Perchlorate Plume for Second Quarter 2018

Nevada Environmental Response Trust Site
Henderson, NV

Date: 10/30/2019	Contract Number: 1690011200-034		Figure
Drafter: AS/RS	Approved:	Revised:	9-11

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APPENDIX A
EVALUATION OF DENSITY DRIVEN FLOW

A. EVALUATION OF DENSITY-DRIVEN FLOW

The density of a contaminant plume may contribute to the direction of solute transport if dissolved concentrations of contaminants are large enough (Johnson et al. 1989). To investigate the effect of density on flow and transport of perchlorate in the subsurface of the NERT Site, a simple three-dimensional model was constructed to represent the subsurface geology beneath the Site up to a depth of approximately 500 feet (ft). The main purpose of this evaluation was to investigate the potential significance of density-driven flow on vertical migration of the perchlorate plume. The variable density groundwater flow and transport code SEAWAT (Guo and Langevin 2002) was employed and the results were compared with scenarios without density-driven flow.

A.1 Model Setup

A simple three-dimensional MODFLOW model was constructed with 34 layers representing 40 ft of alluvium overlying 450 ft of Upper Muddy Creek formation (UMCf) fine-grained unit (UMCf-fg). The top boundary is the groundwater table. The hydraulic parameters were taken from the Phase 5 groundwater flow model (Ramboll Environ 2016). Hydraulic conductivities of 40 feet per day (ft/d) and 0.72 ft/d were applied to the alluvium and UMCf-fg, respectively. Anisotropy ratios were assumed to be 0.1 for the alluvium and 0.01 for the UMCf-fg. The flow regime was defined by constant head boundary conditions at the south (upgradient) and north (downgradient) boundaries producing a horizontal hydraulic gradient of 0.02 in the domain. An average upward vertical gradient of 0.2 ft/ft was specified as observed in onsite well pairs M-71 and M-162.

The simulation was run for 50 years representing the period when sources of perchlorate to groundwater were active. A constant perchlorate concentration of 50,000 mg/L in the top layer was applied for the entire modeling period. The initial concentration of perchlorate was set to 0 mg/L in the aquifer. The model also incorporates the dual porosity mechanism. An estimated industrial recharge rate of 7.3E-4 ft/d (Ramboll Environ 2016) was applied to the top model boundary. The boundary conditions and model schematic setup is presented in Figure A-1.

A.2 Results and discussion

A total of four scenarios (8 runs in each scenario) were simulated by perturbing source concentration, recharge rate, vertical gradient change, and mass transfer rate between mobile and immobile domains. The recharge rate was perturbed by factors of 1, 10, 50 and 100 with respect to current estimated industrial recharge rate of 7.3E-4 ft/d as benchmark. The source concentration increased up to 200,000 mg/L within the solubility limit of perchlorate. The nominal value of vertical gradient (0.2) was changed between 0 vertical gradient to maximum observed vertical gradient (0.65) at well cluster CMT-201 through CMT-207. The mass transfer rate also increased incrementally from zero, for single porosity model to three orders of magnitude higher than its nominal value (3.0E-5 1/d).

For each scenario, a base case was run with density coupling deactivated that was simulated using MT3D. Three observation points were placed beneath the center of source area (assumed as unit building area) at 40, 70 and 100 ft below the groundwater table representing base of alluvium, shallow UMCf-fg, and the deeper UMCf-fg (Figure A-1). Concentration changes were monitored for each run and compared with respect to base case scenario for each observation point. For each scenario normalized concentrations at each observation point were compared to the base case with no density effects.

The sensitivity parameter runs are presented in Table A-1 with the respective maximum concentration difference between the density and non-density models for each scenario at each observation point at the end of the simulations. The model sensitivity results are also presented in Figure A-2. As expected, the model is most sensitive to the initial perchlorate concentration which in the most extreme case can increase the concentration up to 9% with respect to non-density model. The maximum effect of varying the recharge rate is a 2.5% increase and of varying the mass transfer rate and vertical upward gradient a 2% increase.

A.3 Summary

This simple modeling exercise assumed a high source concentration for a 50-yr loading period. The difference between the model results with and without density-driven flow was small. This indicates that density-driven flow has a negligible effect on vertical migration of perchlorate in areas such as at Unit Building 4 where high total dissolved solid concentrations have been observed. However, this study does not rule out the possible effects of density-driven flow on localized flow regimes.

LIST OF TABLES

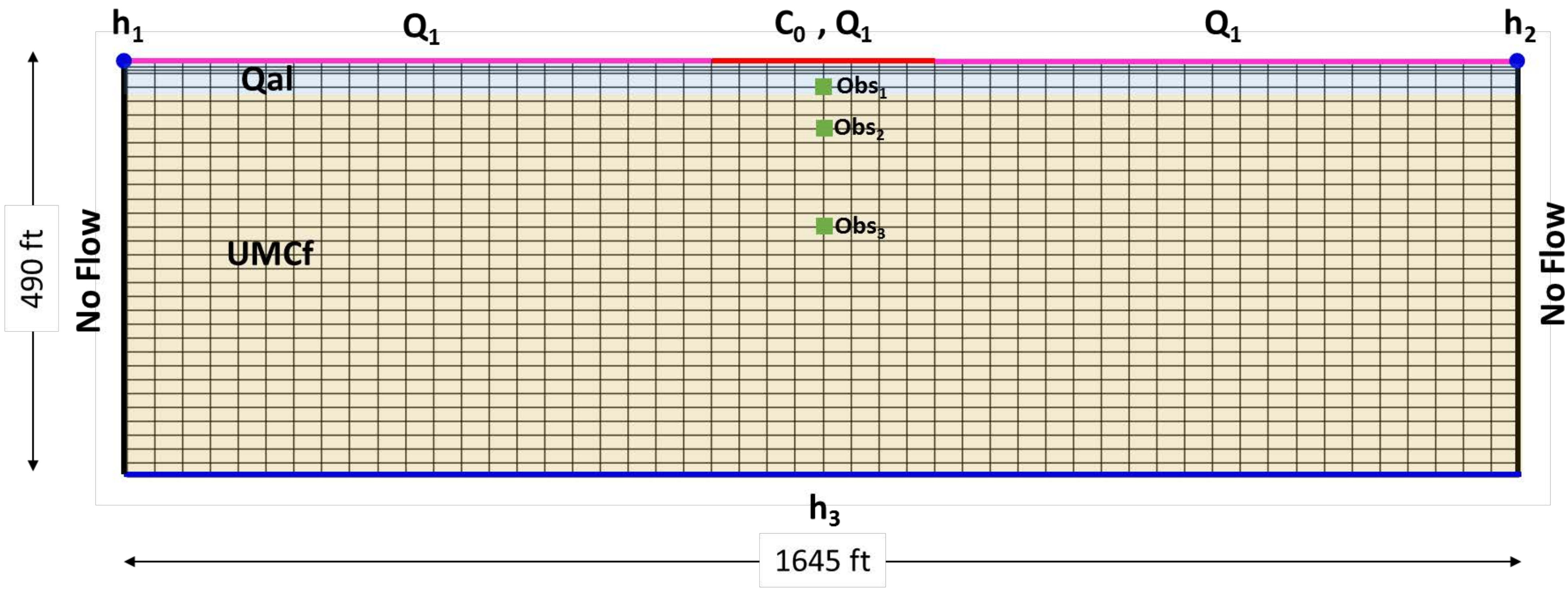
LIST OF FIGURES

TABLE A-1. SENSITIVITY RUNS PARAMETERS AND SUMMARY

Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Scenarios	Model	Concentration [g/L]	Recharge [ft/d]	Vertical Gradient [ft/ft]	Alluvium Mass Transfer Rate [1/d]	UMCf Mass Transfer Rate [1/d]	Maximum Difference after 50 Years
Concentration Perturbation	SEAWAT	**10**	7.30E-04	0.2	3.00E-06	3.00E-05	8.80%
	MT3D	**10**	7.30E-04	0.2	3.00E-06	3.00E-05	
	SEAWAT	**50**	7.30E-04	0.2	3.00E-06	3.00E-05	
	MT3D	**50**	7.30E-04	0.2	3.00E-06	3.00E-05	
	SEAWAT	**100**	7.30E-04	0.2	3.00E-06	3.00E-05	
	MT3D	**100**	7.30E-04	0.2	3.00E-06	3.00E-05	
	SEAWAT	**200**	7.30E-04	0.2	3.00E-06	3.00E-05	
	MT3D	**200**	7.30E-04	0.2	3.00E-06	3.00E-05	
Recharge Rate Perturbation	SEAWAT	50	**7.30E-04**	0.2	3.00E-06	3.00E-05	2.50%
	MT3D	50	**7.30E-04**	0.2	3.00E-06	3.00E-05	
	SEAWAT	50	**7.30E-03**	0.2	3.00E-06	3.00E-05	
	MT3D	50	**7.30E-03**	0.2	3.00E-06	3.00E-05	
	SEAWAT	50	**3.65E-02**	0.2	3.00E-06	3.00E-05	
	MT3D	50	**3.65E-02**	0.2	3.00E-06	3.00E-05	
	SEAWAT	50	**7.30E-02**	0.2	3.00E-06	3.00E-05	
	MT3D	50	**7.30E-02**	0.2	3.00E-06	3.00E-05	
Vertical Gradient Perturbation	SEAWAT	50	7.30E-04	-	3.00E-06	3.00E-05	2.10%
	MT3D	50	7.30E-04	-	3.00E-06	3.00E-05	
	SEAWAT	50	7.30E-04	**0.1**	3.00E-06	3.00E-05	
	MT3D	50	7.30E-04	**0.1**	3.00E-06	3.00E-05	
	SEAWAT	50	7.30E-04	**0.2**	3.00E-06	3.00E-05	
	MT3D	50	7.30E-04	**0.2**	3.00E-06	3.00E-05	
	SEAWAT	50	7.30E-04	**0.65**	3.00E-06	3.00E-05	
	MT3D	50	7.30E-04	**0.65**	3.00E-06	3.00E-05	
Mass Transfer Rate Perturbation	SEAWAT	50	7.30E-04	0.2	**Single Prosity**	**Single Prosity**	2.10%
	MT3D	50	7.30E-04	0.2	**Single Prosity**	**Single Prosity**	
	SEAWAT	50	7.30E-04	0.2	**3.00E-06**	**3.00E-05**	
	MT3D	50	7.30E-04	0.2	**3.00E-06**	**3.00E-05**	
	SEAWAT	50	7.30E-04	0.2	**3.00E-04**	**3.00E-03**	
	MT3D	50	7.30E-04	0.2	**3.00E-04**	**3.00E-03**	
	SEAWAT	50	7.30E-04	0.2	**3.00E-03**	**3.00E-02**	
	MT3D	50	7.30E-04	0.2	**3.00E-03**	**3.00E-02**	

Notes:
1/d = per day
ft/d = feet per day
ft/ft = foot per foot
g/L = grams per liter



RAMBOLL

Boundary Value Problem for Density Driven Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Figure A-1

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PROJECT: 1690011200-034

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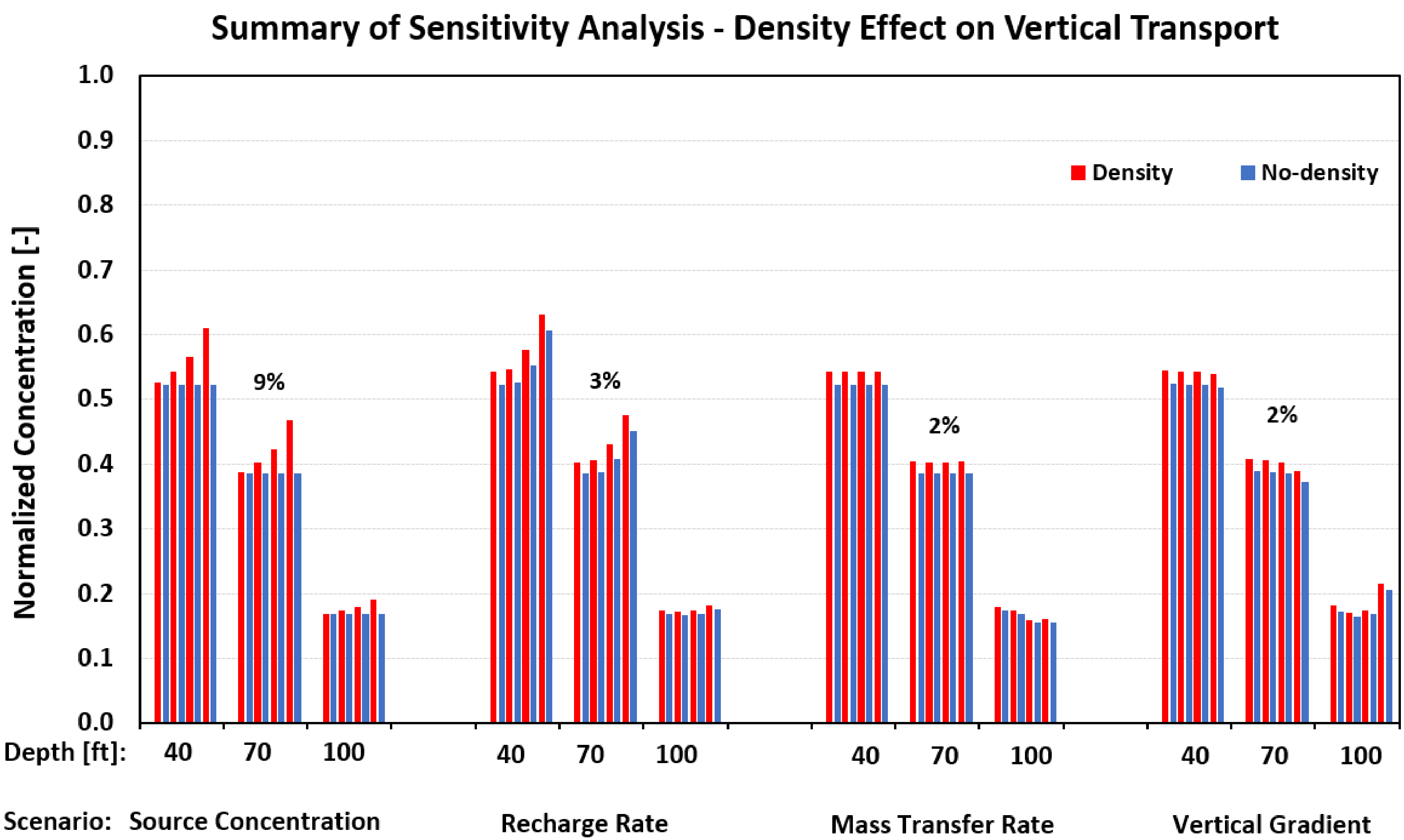

RAMBOLL	**Summary of Sensitivity Analysis - Density Effect on Vertical Transport** Nevada Environmental Response Trust Site Henderson, Nevada	Figure A-2
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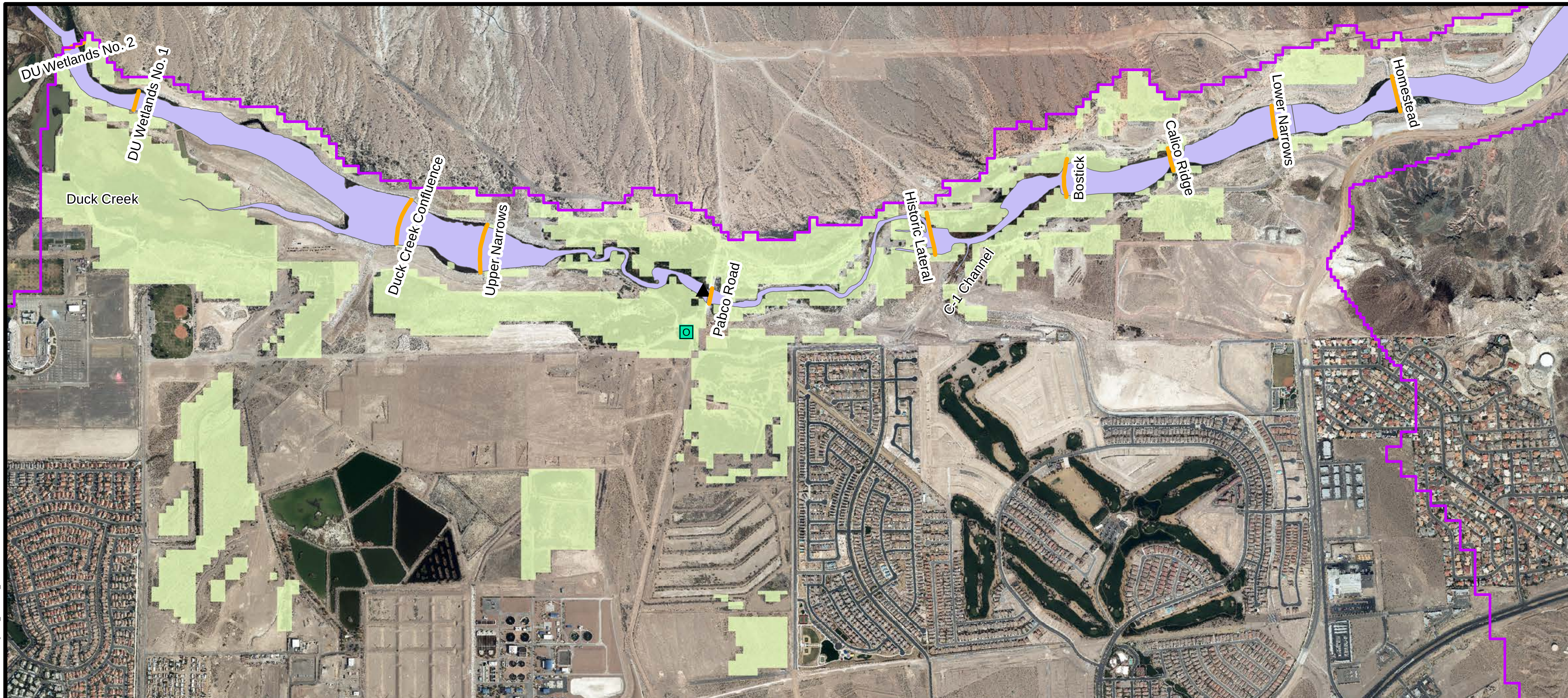
APPENDIX B
EVAPOTRANSPIRATION ZONES (2014-2018)



Explanation

- Phase 6 Model Extent
- SNWA Weir
- O NERT/AMPAC/TIMET/COH Outfall Location
- ▲ USGS Stream Gauge Station
- Las Vegas Wash in 2017
- Areas of Phreatophytes in 2014

Note: Clark County 4-band digital aerials for March 2014 are shown, image courtesy of Southern Nevada Water Authority (SNWA).

N W E S

0 0.25 0.5 Mile

RAMBOLL

DRAFTED BY: LR | DATE: 5/1/2019

AREA OF PHREATOPHYTES NEAR LAS VEGAS WASH IN 2014

Nevada Environmental Response Trust Site
Henderson, Nevada

Figure
B-1

PROJECT: 1690011200-034

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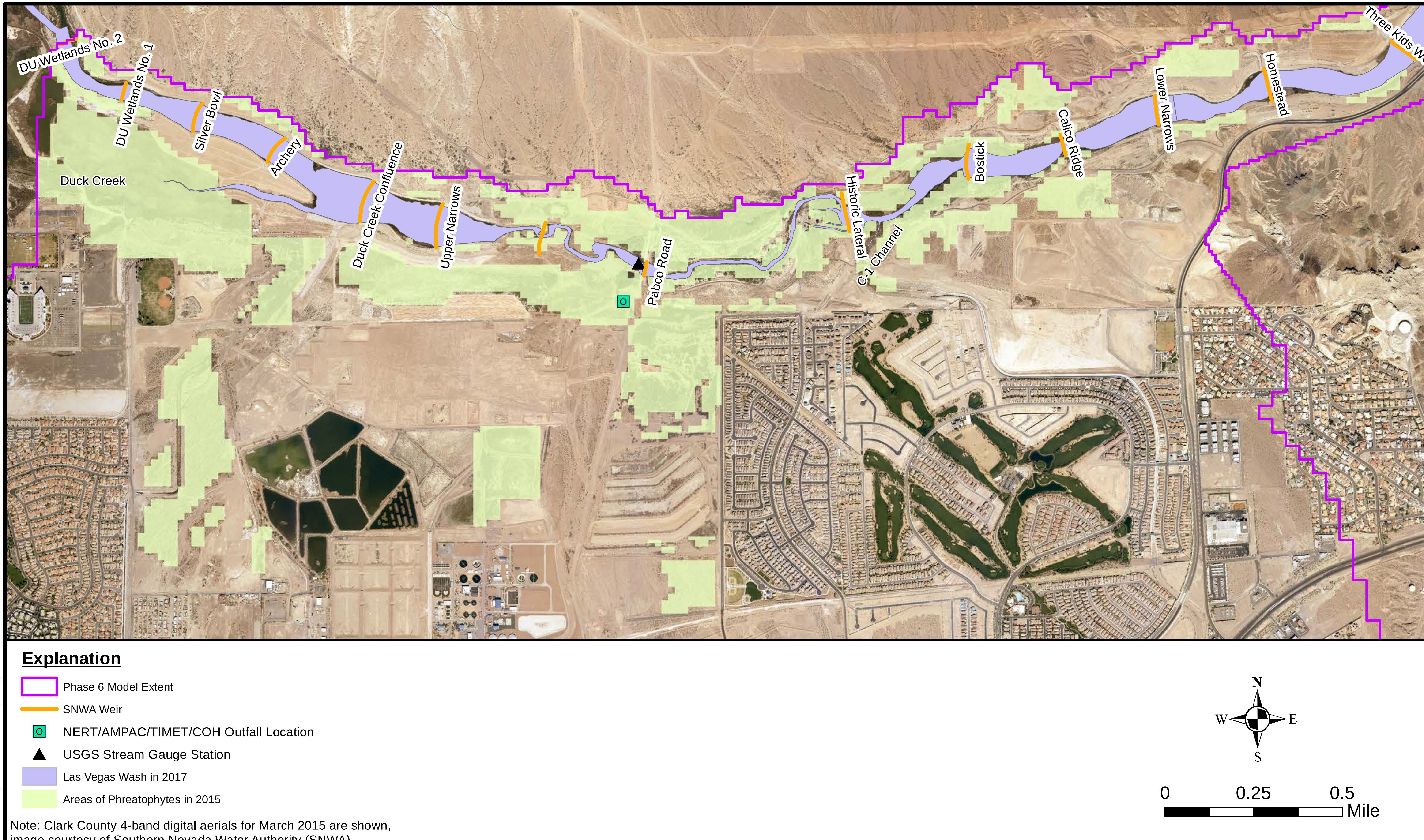

Note: Clark County 4-band digital aerials for March 2015 are shown, image courtesy of Southern Nevada Water Authority (SNWA).

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RAMBOLL

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AREA OF PHREATOPHYTES NEAR LAS VEGAS WASH IN 2015

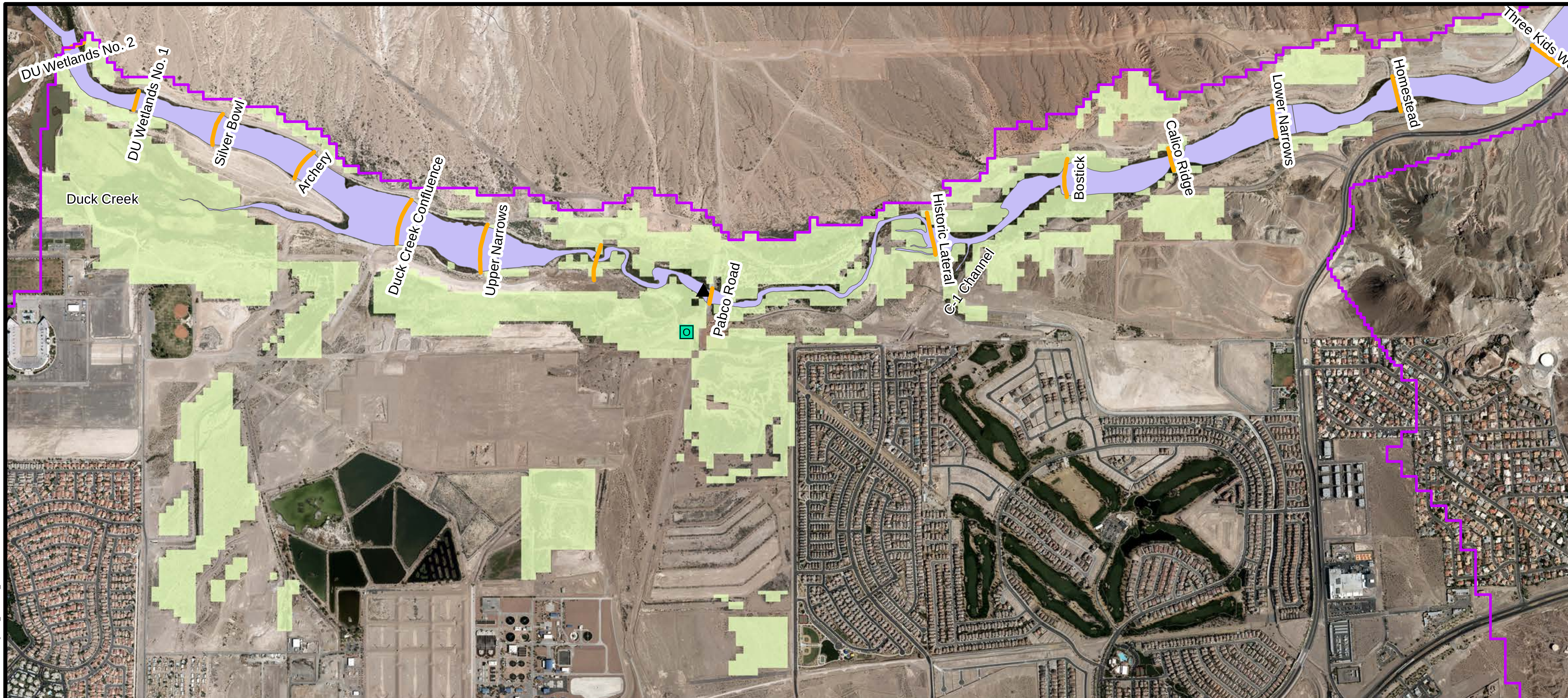
Nevada Environmental Response Trust Site

Henderson, Nevada

Figure

B-2

PROJECT: 1690011200-034



Explanation

- Phase 6 Model Extent
- SNWA Weir
- NERT/AMPAC/TIMET/COH Outfall Location
- USGS Stream Gauge Station
- Las Vegas Wash in 2017
- Areas of Phreatophytes in 2016

Note: Clark County 4-band digital aerials for March 2016 are shown, image courtesy of Southern Nevada Water Authority (SNWA).

N
W E
S

0 0.25 0.5 Mile

RAMBOLL

DRAFTED BY: LR | DATE: 5/1/2019

AREA OF PHREATOPHYTES NEAR LAS VEGAS WASH IN 2016

Nevada Environmental Response Trust Site

Henderson, Nevada

Figure

B-3

PROJECT: 1690011200-034

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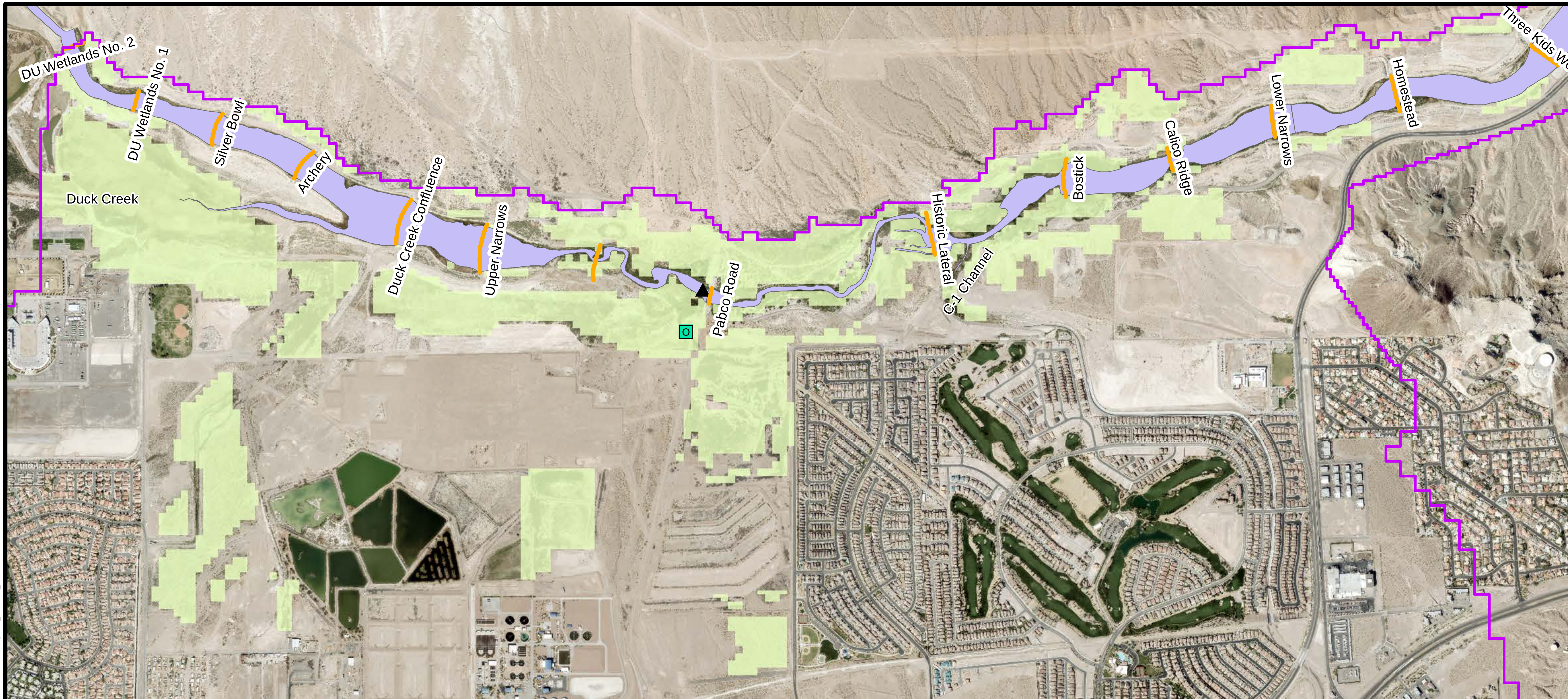

Explanation

- Phase 6 Model Extent
- SNWA Weir
- NERT/AMPAC/TIMET/COH Outfall Location
- USGS Stream Gauge Station
- Las Vegas Wash in 2017
- Areas of Phreatophytes in 2017

Note: Clark County 4-band digital aerials for March 2017 are shown, image courtesy of Southern Nevada Water Authority (SNWA).

N E S W

0 0.25 0.5 Mile

RAMBOLL

DRAFTED BY: LR | DATE: 5/1/2019

AREA OF PHREATOPHYTES NEAR LAS VEGAS WASH IN 2017

Nevada Environmental Response Trust Site

Henderson, Nevada

Figure

B-4

PROJECT: 1690011200-034

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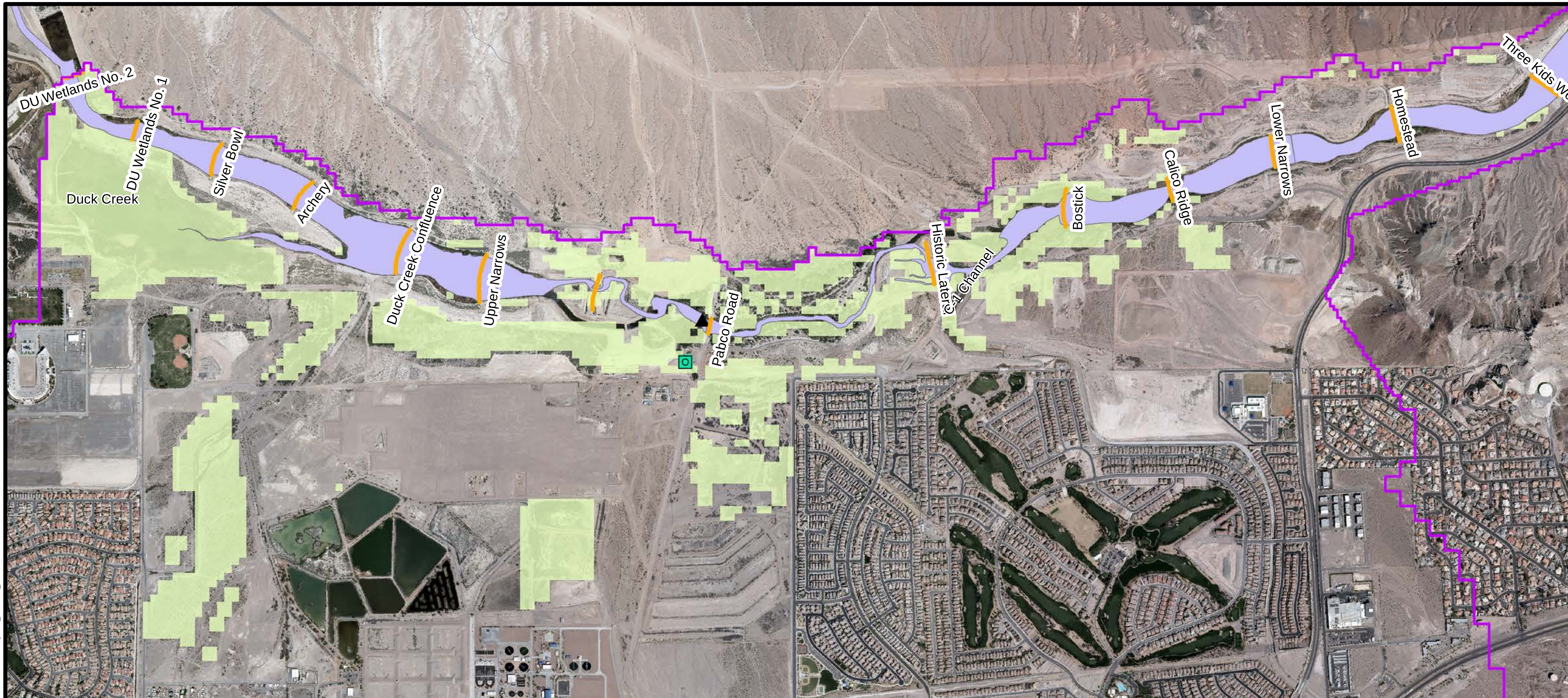

Explanation

- Phase 6 Model Extent
- SNWA Weir
- NERT/AMPAC/TIMET/COH Outfall Location
- USGS Stream Gauge Station
- Las Vegas Wash in 2017
- Areas of Phreatophytes in 2018

Note: Clark County 4-band digital aerials for March 2018 are shown, image courtesy of Southern Nevada Water Authority (SNWA).

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RAMBOLL

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AREA OF PHREATOPHYTES NEAR LAS VEGAS WASH IN 2018

Nevada Environmental Response Trust Site

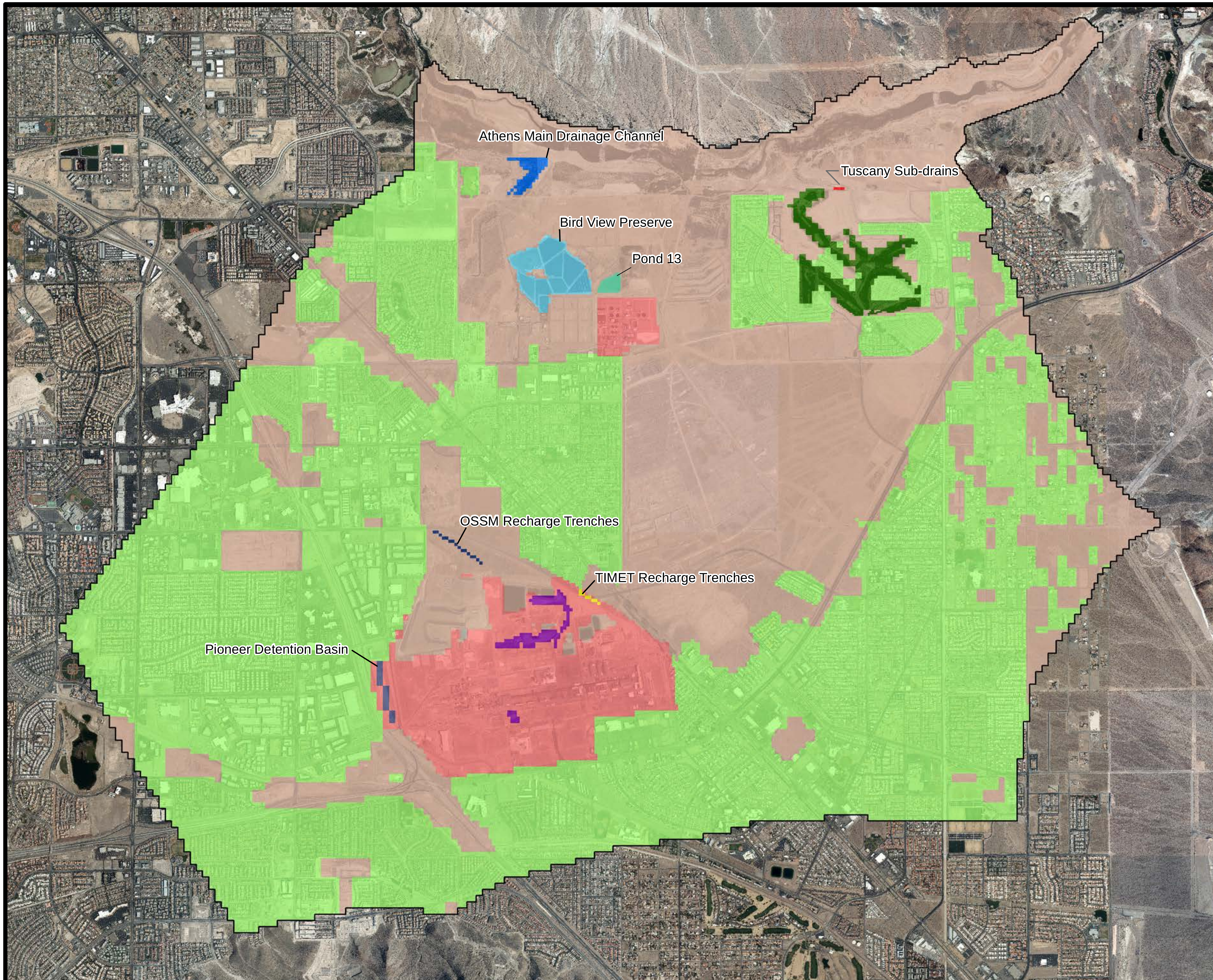
Henderson, Nevada

Figure

B-5

PROJECT: 1690011200-034

APPENDIX C
AREAL RECHARGE COMPONENTS (2014 -2018)



EXPLANATION

- Phase 6 Model Extent
- Undeveloped
- Residential Area
- Industrial Area
- NERT Retention Basins
- Golf Course
- Pioneer Detention Basin
- Bird View Preserve (BVP)
- Athens Main Drainage Channel
- TIMET Recharge Trenches
- Tuscany Sub-drains
- OSSM Recharge Trenches
- Pond 13

N W E S

0 2,500 5,000 Feet

RAMBOLL

RECHARGE ZONES - 2014

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 9/16/2019	Contract Number: 1690011200-034		Figure
Drafter: AS	Approved:	Revised:	C-1

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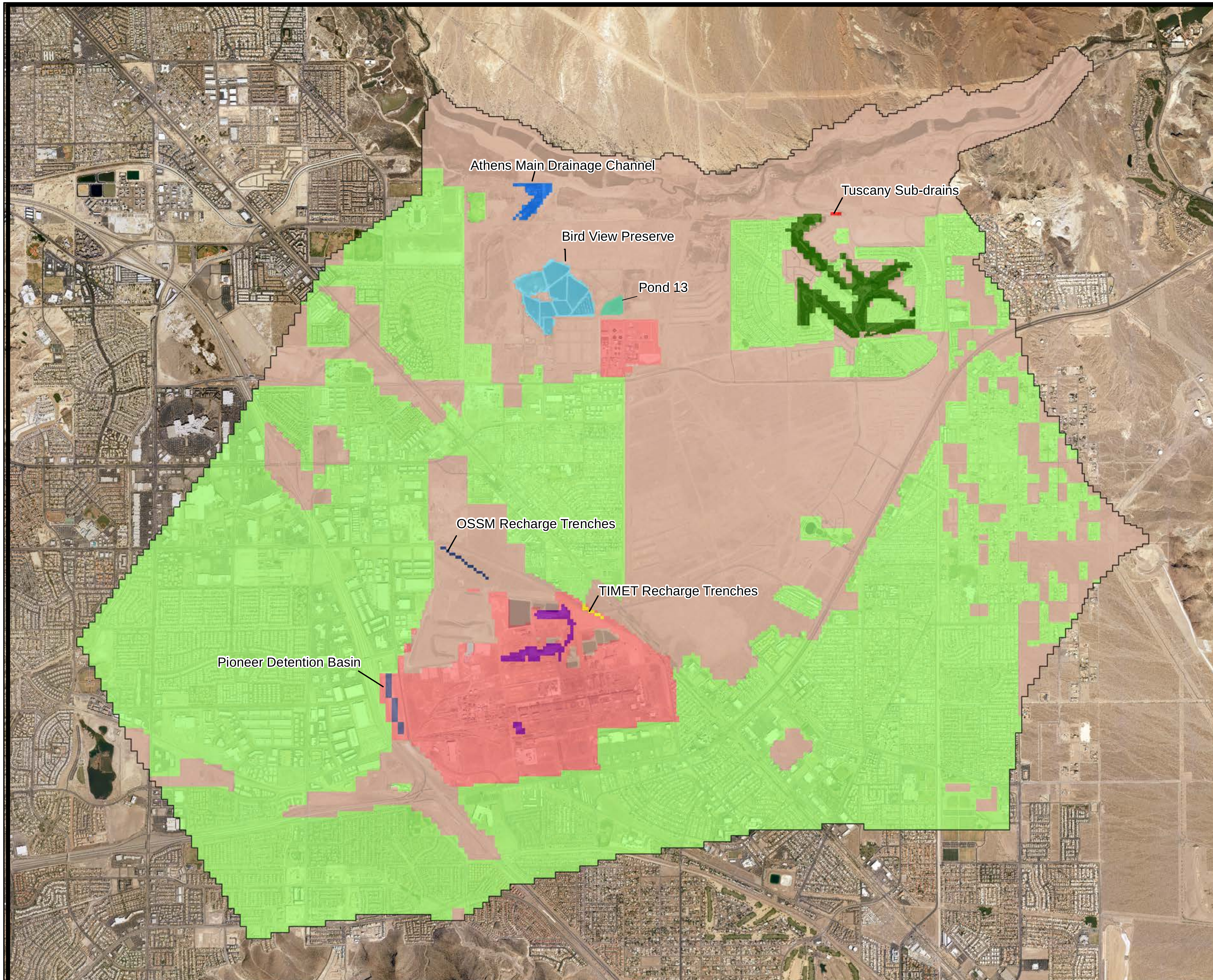

EXPLANATION

- Phase 6 Model Extent
- Undeveloped
- Residential Area
- Industrial Area
- NERT Retention Basins
- Golf Course
- Pioneer Detention Basin
- Bird View Preserve (BVP)
- Athens Main Drainage Channel
- TIMET Recharge Trenches
- Tuscany Sub-drains
- OSSM Recharge Trenches
- Pond 13

N
W E
S

0 2,500 5,000
Feet

RAMBOLL

RECHARGE ZONES - 2015
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 9/16/2019	Contract Number: 1690011200-034		Figure
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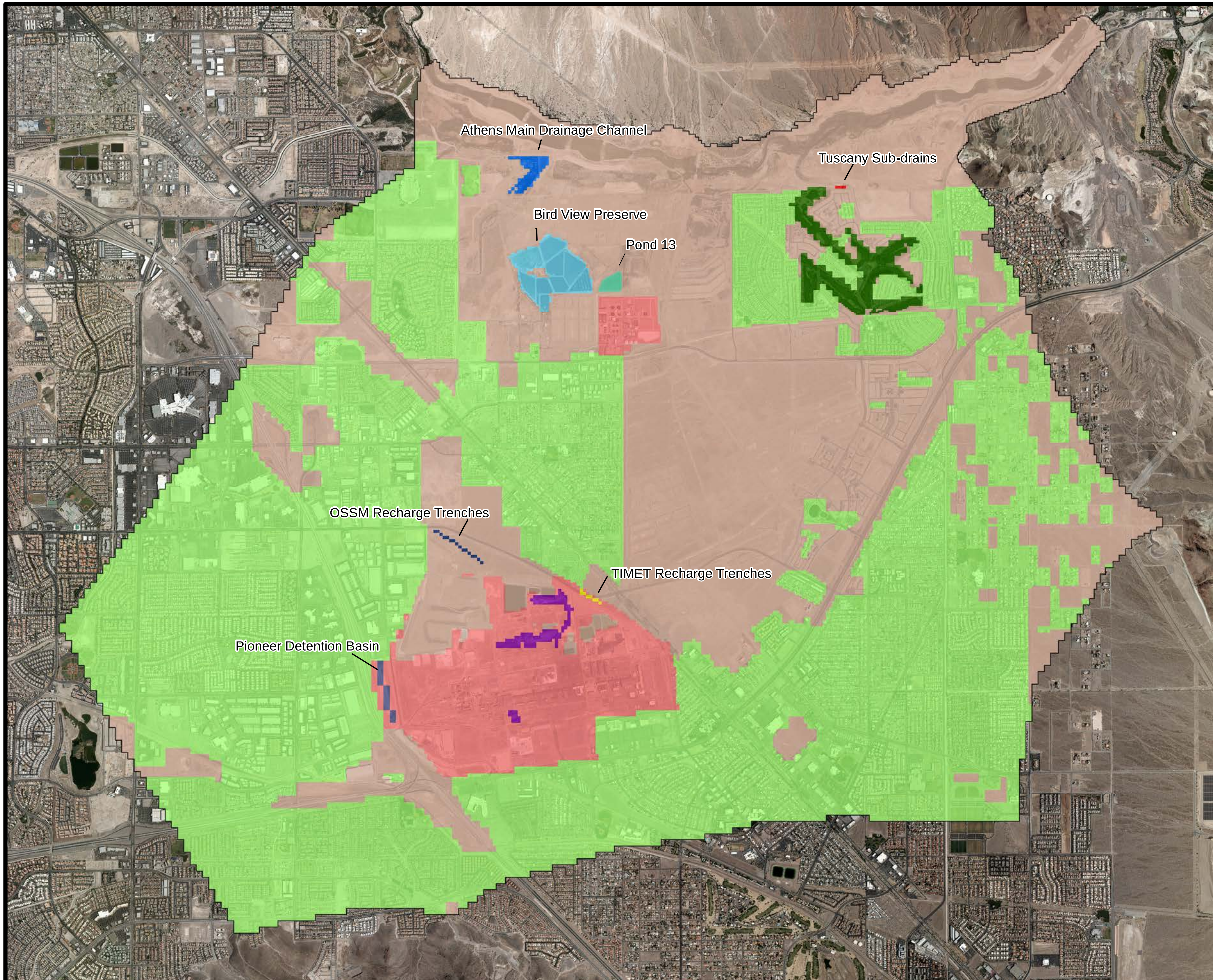

EXPLANATION

DRAFT

- Phase 6 Model Extent
- Undeveloped
- Residential Area
- Industrial Area
- NERT Retention Basins
- Golf Course
- Pioneer Detention Basin
- Bird View Preserve (BVP)
- Athens Main Drainage Channel
- TIMET Recharge Trenches
- Tuscany Sub-drains
- OSSM Retention Trenches
- Pond 13

N
W E
S

0 2,500 5,000
Feet

RAMBOLL

RECHARGE ZONES - 2016
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 11/19/2019	Contract Number: 1690011200-034		Figure C-3
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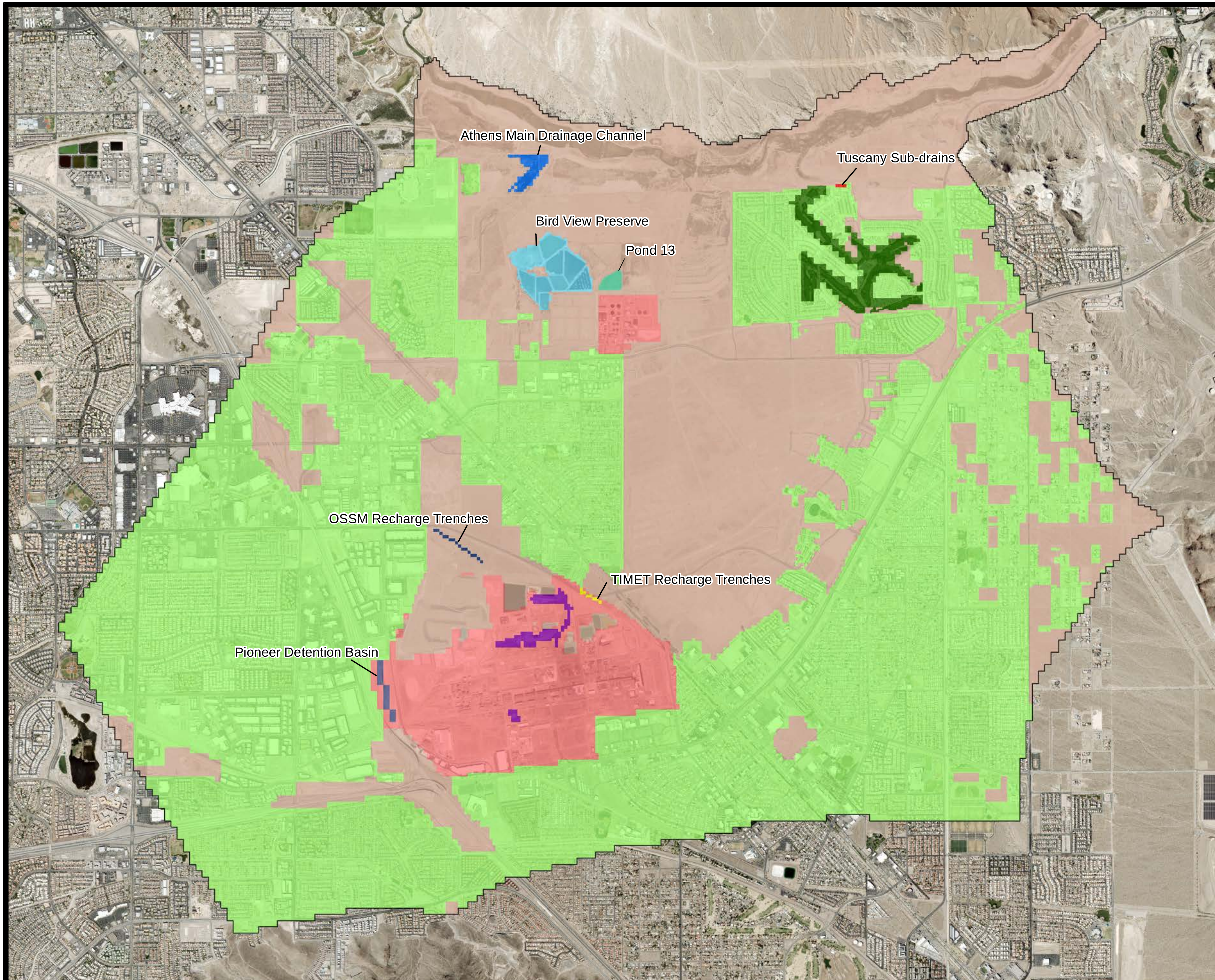

DRAFT

EXPLANATION

- Phase 6 Model Extent
- Undeveloped
- Residential Area
- Industrial Area
- NERT Retention Basins
- Golf Course
- Pioneer Detention Basin
- Bird View Preserve (BVP)
- Athens Main Drainage Channel
- TIMET Recharge Trenches
- Tuscany Sub-drains
- OSSM Retention Trenches
- Pond 13

N W E S

0 2,500 5,000 Feet

RAMBOLL

RECHARGE ZONES - 2017

Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 9/16/2019	Contract Number: 1690011200-034		Figure
Drafter: AS	Approved:	Revised:	C-4

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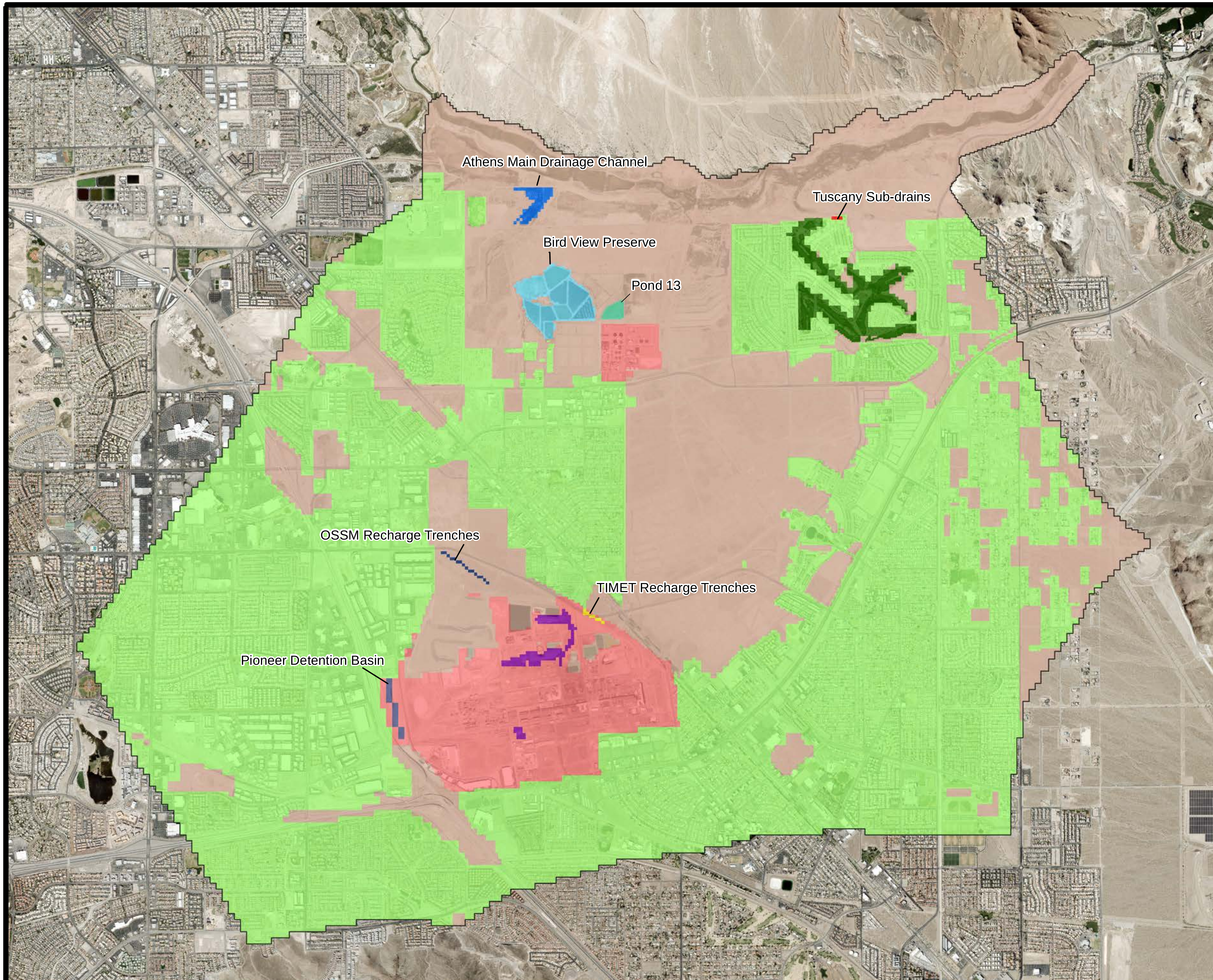

EXPLANATION

DRAFT

- Phase 6 Model Extent
- Undeveloped
- Residential Area
- Industrial Area
- NERT Retention Basins
- Golf Course
- Pioneer Detention Basin
- Bird View Preserve (BVP)
- Athens Main Drainage Channel
- TIMET Recharge Trenches
- Tuscany Sub-drains
- OSSM Recharge Trenches
- Pond 13

N
W E
S

0 2,500 5,000
Feet

RAMBOLL

RECHARGE ZONES - 2018
Nevada Environmental Response Trust Site
Henderson, Nevada

Date: 9/16/2019	Contract Number: 1690011200-034		Figure C-5
Drafter: AS	Approved:	Revised:	

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APPENDIX D
SUMMARY OF HISTORICAL HYDRAULIC TESTING

D. INTRODUCTION

This appendix presents the results of numerous aquifer tests and laboratory physical parameter tests conducted within the model domain of the Nevada Environmental Response Trust (Trust) Site located in Henderson, Nevada (the "Site") since 1980. Data from all known tests were used to update the distributions of hydraulic conductivity and storage parameter estimates for lithologic units included in the Phase 6 model (see Section 5.3). A discussion of how testing results were statistically summarized is included in this appendix.

D.1 Aquifer Testing Results Datasets

Results from aquifer testing and laboratory physical parameter testing were compiled from both recent investigations and historic documents. Estimated horizontal hydraulic conductivity, estimated vertical hydraulic conductivity, and estimated storage parameters from these sources are included in Tables D-1, D-2, and D-3, respectively. The data's sources are noted in the tables.

D.1.1 Recent Studies and Investigations

Horizontal hydraulic conductivity values estimated during the following recent studies and investigations were included in the aquifer testing results dataset presented in Table D-1[1]:

- **Phase 1 RI:** Slug tests were completed at select wells screened in the middle WBZ within the fine-grained UMCf in early 2015.
- **Phase 2 RI:** Select wells were slug tested in Fall 2017 and March 2019 as part of the Phase 2 RI.
- **Phase 3 RI:** Slug tests were performed in select wells between February and October 2018.
- **Unit 4 and 5 Investigation:** Slug tests were conducted in select wells located near Unit Buildings 4 and 5 in OU-1.
- **Pilot and Treatability Studies:** Slug, pumping, and specific capacity tests were conducted as part of the Seep Well Field Area Bioremediation Treatability Study, Galleria Drive Bioremediation Treatability Study, Las Vegas Wash Bioremediation Pilot Study, Unit 4 In-Situ Bioremediation Treatability Study, In-Situ Chromium Treatability Study, and the AP Area Treatability Study.

D.1.2 Historic Documents

Since the 1980s, over forty documents that include results from aquifer testing and laboratory physical parameter testing from different areas of the Site have been produced. Estimated horizontal hydraulic conductivity, estimated vertical hydraulic conductivity, and estimated storage parameters from these reports are included in Tables D-1, D-2, and D-3, respectively. Due to inconsistent well/boring names and varied report formats, there is uncertainty that every historic aquifer test result was labeled with the appropriate location and screened lithology. The following quality analysis efforts were taken to minimize error: Location information is included from the January 2019 NDEP All Wells Database (AWDB) unless incongruities with the source document were identified (e.g., an aquifer test was conducted at B-1, but a map within the source document depicts B-1 in a different location than the AWDB location). In these instances, coordinates from the source document were used if available.

[1] Results from aquifer testing conducted by AECOM as part of the Downgradient Investigation were not available for this analysis.

Similarly, the lithologic unit of the well's screened interval was assigned from the AWDB unless the source report contained information about which aquifer unit was tested. The AWDB lithologic unit was overwritten for:

- Results from aquifer tests conducted in the paleochannels or Las Vegas Wash (as estimated in the Phase 5 Model), which were assigned distinct lithologic units since the hydraulic properties in those areas differ from those of the Quaternary Alluvium (Qal); and
- A limited number of locations (H-36, H-43, I-AA, M-17, PC-133), where it was determined that the hydraulic conductivity estimate was more representative of another lithologic unit after the depth to the Upper Muddy Creek formation (UMCf) at the location, the depth of that location's screened interval, and the overall distribution of hydraulic conductivity estimates for each lithologic unit were evaluated.

The variety of aquifer test methods used at the Site by different contractors were categorized as slug, pump, lab, or specific capacity tests. Slug tests include both falling head and rising head tests, as well as piezometer bail tests. Pump tests include constant rate, constant head, recovery, step, and tracer tests. Lab tests include flexible wall permeameter tests in addition to falling and constant head permeability tests.

D.2 Statistical Summary of Hydraulic Conductivity Estimates

The maximum, minimum, and geometric mean hydraulic conductivity for each lithologic unit in the model domain was calculated using the average hydraulic conductivities for each test method for all well locations.

Some aquifer test results were excluded before average hydraulic conductivities at each well location were calculated. Results were excluded in the following instances:

- The reported result was a transmissivity value and no aquifer thickness was available for that test location;
- The lithologic unit in which aquifer testing occurred was unclear, either because location information could not be identified or well/boring logs were not available; or
- The result was reported as an average and the source of the original values was unclear. In these cases, including an average hydraulic conductivity in the calculation of a new average hydraulic conductivity could cause inadvertent weighting of individual test results.

Figure D-1 shows the statistical distribution of average horizontal hydraulic conductivity estimates for each method within each lithologic unit. The statistics for horizontal and vertical hydraulic conductivity are also summarized in Table 4.

LIST OF TABLES

LIST OF FIGURES

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
AA-07	Qal	8	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-07	Qal	5	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-07	Qal	6.5	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-07	Qal	8	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-08	Paleochannels	50	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-08	Paleochannels	70.1	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-08	Paleochannels	40	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-08	Paleochannels	62.1	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-08	Paleochannels	654	Pump	--	Kleinfelder 2007b
AA-08	Paleochannels	192	Step	--	Kleinfelder 2007b
AA-08	Paleochannels	417	Pump	--	Kleinfelder 2007b
AA-08	Paleochannels	564	Pump	--	Kleinfelder 2007b
AA-08	Paleochannels	446	Pump	--	Kleinfelder 2007b
AA-08	Paleochannels	846	Pump	--	Kleinfelder 2007b
AA-08	Paleochannels	451	Pump	--	Kleinfelder 2007b
AA-09	Paleochannels	67.3	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-09	Paleochannels	58.4	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-09	Paleochannels	62	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-09	Paleochannels	9.6	Pump	--	Kleinfelder 2007b
AA-09	Paleochannels	9.6	Pump	--	Kleinfelder 2007b
AA-09	Paleochannels	12	Step	--	Kleinfelder 2007b
AA-09	Paleochannels	15.4	Pump	--	Kleinfelder 2007b
AA-09	Paleochannels	14.4	Pump	--	Kleinfelder 2007b
AA-09	Paleochannels	2.6	Slug	Zlotnick, Goss and Dufield (2010)	[2]
AA-09	Paleochannels	2.5	Slug	Zlotnick, Goss and Dufield (2010)	[2]
AA-09	Paleochannels	3.9	Slug	Zlotnick, Goss and Dufield (2010)	[2]
AA-09	Paleochannels	3.2	Slug	Zlotnick, Goss and Dufield (2010)	[2]
AA-13	Qal/UMCf	12.2	Slug	Bouwer-Rice	Kleinfelder 2007b

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
AA-13	Qal/UMCf	11.2	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-13	Qal/UMCf	14.2	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-13	Qal/UMCf	12.5	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-20	Paleochannels	22.7	Pump	--	Kleinfelder 2007b
AA-20	Paleochannels	29.7	Pump	--	Kleinfelder 2007b
AA-20	Paleochannels	29	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-20	Paleochannels	32.5	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-20	Paleochannels	44	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-20	Paleochannels	33.6	Step	--	Kleinfelder 2007b
AA-20	Paleochannels	69	Pump	--	Kleinfelder 2007b
AA-20	Paleochannels	52.1	Pump	--	Kleinfelder 2007b
AA-22	Qal	0.6	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-22	Qal	0.5	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-22	Qal	0.3	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-22	Qal	0.6	Slug	Bouwer-Rice	Kleinfelder 2007b
AA-23R	Qal	8.84	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-23R	Qal	10	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-23R	Qal	8.6	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-23R	Qal	12.5	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-23R	Qal	9.78E-03	Lab	--	Kleinfelder 2007a
AA-26	Qal	4.1	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-26	Qal	1.58	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-26	Qal	2.45	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-26	Qal	1.65	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
AA-30	Qal	29.6	Slug	Hvorslev	Converse Consultants 2009
AA-30	Qal	24.05	Slug	Bouwer and Rice	Converse Consultants 2009
AA-30	Qal	24.1	Slug	Hvorslev	Converse Consultants 2009
AA-30	Qal	17.9	Slug	Bouwer Rice	Converse Consultants 2009

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
AA-30	Qal	32.5	Slug	Hvorslev	Converse Consultants 2009
AA-30	Qal	32.5	Slug	Bouwer Rice	Converse Consultants 2009
AA-30	Qal	17.9	Slug	Hvorslev	Converse Consultants 2009
AA-30	Qal	13.3	Slug	Bouwer Rice	Converse Consultants 2009
AA-30	Qal	43.9	Slug	Hvorslev	Converse Consultants 2009
AA-30	Qal	32.5	Slug	Bouwer Rice	Converse Consultants 2009
AA-30	Qal	29.6	Pump	Hvorslev	Converse Consultants 2009
AA-30	Qal	24.05	Pump	Bouwer-Rice	Converse Consultants 2009
AA-BW-01A	Qal	4.5	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-01A	Qal	5	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-01A	Qal	4.5	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-01A	Qal	5	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-07A	Qal	4.5	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-07A	Qal	5	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-07A	Qal	4.7	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-07A	Qal	5.1	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-07A	Qal	4.9	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-07A	Qal	5.3	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-08A	Qal	22.6	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-08A	Qal	26	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-08A	Qal	31	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-08A	Qal	32	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-08A	Qal	30.5	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-08A	Qal	26	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-12A	Qal	20.8	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-12A	Qal	23.1	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-12A	Qal	38	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-12A	Qal	27.5	Slug	Bouwer-Rice	Kleinfelder 2008

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
AA-BW-12A	Qal	22	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-12A	Qal	31	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-12A	Qal	31	Slug	Bouwer-Rice	Kleinfelder 2008
AA-BW-12A	Qal	18.8	Slug	Bouwer-Rice	Kleinfelder 2008
AA-MW-20	xMCf/UMCf	2	Slug	Hvorslev	Geosyntec 2014
AA-MW-21	xMCf/UMCf	8.1	Slug	Hvorslev	Geosyntec 2014
AA-MW-22	xMCf/UMCf	5.2	Slug	Hvorslev	Geosyntec 2014
AA-MW-23	xMCf/UMCf	5.4	Slug	Hvorslev	Geosyntec 2014
ADX-112	UMCf	6.76E-04	Slug	Bouwer-Rice	Geosyntec 2010
AMEW-1	UMCf-cg	5.17	Pump	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-1	UMCf-cg	5.17	Pump	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-2	UMCf-cg	2.674998073	Pump	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-3	UMCf-cg	5.633329275	Pump	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-4	UMCf-cg	3.34	Pump	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-4	UMCf-cg	3.51	Pump	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-5	UMCf-cg	0.69	Pump	Hantush-Jacob Leaky	AMPAC 2011b
AMX-40	UMCf	4.263	Slug	Bouwer-Rice	Geosyntec 2010
AMX-40	UMCf	3.983	Slug	Bouwer-Rice	Geosyntec 2010
AMX-40	UMCf	4.421	Slug	Bouwer-Rice	Geosyntec 2010
AMX-40	UMCf	4.091	Pump	--	AMPAC 2011a
AMX-98	UMCf	4.376	Slug	Bouwer-Rice	Geosyntec 2010
ART-1	Paleochannels	88	Step	Jacobs semi-log straight line	PC-133 Pump Test Analyses 2004
ART-1	Paleochannels	53	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-1	Paleochannels	37	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-1	Paleochannels	200	Pump	Moench	Ramboll Environ 2013
ART-1	Paleochannels	29	Step	--	Hydraulic Conductivity ART 2001
ART-2	Paleochannels	515	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-2	Paleochannels	480	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
ART-2	Paleochannels	451	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-2	Paleochannels	278	Step	--	Hydraulic Conductivity ART 2001
ART-3	Paleochannels	87	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-3	Paleochannels	76	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-3	Paleochannels	35	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-3	Paleochannels	15	Step	--	Hydraulic Conductivity ART 2001
ART-4	Paleochannels	105	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-4	Paleochannels	88	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-4	Paleochannels	75	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-4	Paleochannels	23	Pump	Moench	Ramboll Environ 2013
ART-4	Paleochannels	55	Step	--	Hydraulic Conductivity ART 2001
ART-5	Paleochannels	89	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-5	Paleochannels	66	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-5	Paleochannels	48	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-6	Paleochannels	181	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-6	Paleochannels	168	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-6	Paleochannels	151	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-6	Paleochannels	146	Step	--	Hydraulic Conductivity ART 2001
ART-7	Paleochannels	402	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-7	Paleochannels	355	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-7	Paleochannels	348	Step	Jacobs semi-log straight line	Hydraulic Conductivity ART 2001
ART-7	Paleochannels	262	Step	--	Hydraulic Conductivity ART 2001
ART-7A	Paleochannels	228	Pump	Moench	Ramboll Environ 2013
ART-7B	Paleochannels	243	Step	Moench	Ramboll Environ 2013
ART-8	Paleochannels	163	Step	--	Hydraulic Conductivity ART 2001
ART-9	Paleochannels	140	Step	--	Hydraulic Conductivity ART 2001
ART-9	Paleochannels	255	Pump	Moench	Ramboll Environ 2013
B-1	Wash Gravels	0.16	Lab	--	Converse Consultants 2002

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
B-1	Wash Gravels	1.11E-03	Slug	--	GES 2005b
B-1	Wash Gravels	0.74	Lab	--	Ninyo & Moore 2004
B-1	Wash Gravels	3.40E-03	Lab	--	Ninyo & Moore 2004
B-1	Wash Gravels	0.16	Slug	Hvorslev	Converse Consultants 1986
B-10	Wash Gravels	1.13E-03	Lab	--	Converse Consultants 2006a
B-103	Wash Gravels	1.09E-03	Lab	--	Converse Consultants 1999
B-105	Wash Gravels	0.86	Lab	--	Converse Consultants 1999
B-11	Wash Gravels	0.61	Lab	--	Converse Consultants 2006b
B-11	Wash Gravels	1.76E-03	Lab	--	Converse Consultants 2006a
B-12	Wash Gravels	4.99E-04	Lab	--	Converse Consultants 1999
B-13	Wash Gravels	2.81E-04	Lab	--	Converse Consultants 2006a
B-14	Wash Gravels	1.17	Lab	--	Converse Consultants 2006b
B-14	Wash Gravels	0.52	Lab	--	Converse Consultants 2006b
B14R	Qal	72.5	Slug	Bouwer-Rice	Kleinfelder 2008
B14R	Qal	80	Slug	Bouwer-Rice	Kleinfelder 2008
B14R	Qal	62.5	Slug	Bouwer-Rice	Kleinfelder 2008
B14R	Qal	65	Slug	Bouwer-Rice	Kleinfelder 2008
B14R	Qal	67	Slug	Bouwer-Rice	Kleinfelder 2008
B14R	Qal	67	Slug	Bouwer-Rice	Kleinfelder 2008
B-2	Wash Gravels	1.95E-02	Lab	--	Converse Consultants 2002
B-2	Wash Gravels	0.31	Slug	--	GES 2005b
B-2	Wash Gravels	0.470551181	Slug	--	GES 2007b
B-2	Wash Gravels	0.02736	Slug	Hvorslev	Converse Consultants 1986
B-3	Wash Gravels	0.13	Slug	--	Converse Consultants 2006a
B-3	Wash Gravels	1.92	Slug	--	GES 2005a
B-3	Wash Gravels	6.43E-04	Slug	--	GES 2007b
B-3	Wash Gravels	0.13	Slug	--	GES 2007c
B-3	Wash Gravels	8.06E-02	Slug	Hvorslev	Converse Consultants 1986

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
B-4	Wash Gravels	9.16E-03	Lab	--	Converse Consultants 2002
B-4	Wash Gravels	5.13E-04	Slug	--	Converse Consultants 2006a
B-4	Wash Gravels	0.32	Slug	--	GES 2005a
B-4	Wash Gravels	5.13E-04	Slug	--	GES 2007c
B-4	Wash Gravels	1.67	Lab	--	Ninyo & Moore 2004
B-4	Wash Gravels	0.42	Lab	--	Converse Consultants 1999
B-4	Wash Gravels	0.12	Slug	Hvorslev	Converse Consultants 1986
B-5	Wash Gravels	0.44	Lab	--	Converse Consultants 2002
B-5	Wash Gravels	6.35E-03	Slug	--	GES 2005a
B-5	Wash Gravels	1.11	Lab	--	Ninyo & Moore 2004
B-6	Wash Gravels	0.14	Lab	--	Converse Consultants 2002
B-6	Wash Gravels	3.91E-03	Lab	--	Converse Consultants 2002
B-6	Wash Gravels	6.24	Lab	--	Converse Consultants 2006a
B-6	Wash Gravels	6.24	Lab	--	GES 2007c
B-6	Wash Gravels	4.03E-02	Slug	Hvorslev	Converse Consultants 1986
B-7	Wash Gravels	0.64	Lab	--	Converse Consultants 2002
B-7	Wash Gravels	0.99	Lab	--	Converse Consultants 2006a
B-7	Wash Gravels	7.88E-04	Slug	--	GES 2007a
B-7	Wash Gravels	0.99	Lab	--	GES 2007c
B-8	Wash Gravels	2.98E-03	Slug	--	Converse Consultants 2006a
B-8	Wash Gravels	2.64E-02	Slug	--	GES 2007a
B-8	Wash Gravels	2.98E-03	Slug	--	GES 2007c
B-8	Wash Gravels	8.22E-02	Lab	--	Converse Consultants 1999
BEC-10	UMCf	0.018	Slug	Zlotnick, Goss and Dufield (2010)	[2]
BS-3	Wash Gravels	12.47	Lab	--	Converse Consultants 2002
BS-4	Wash Gravels	9.35E-02	Lab	--	Converse Consultants 2002
BS-5	Wash Gravels	2.267716535	Lab	--	Converse Consultants 2002
CLD1-R	Qal	70.27023452	Pump	Cooper & Jacob, recovery	TIMET 2007

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
CLD1-R	Qal	17.31	Not Available	Theis recovery	Tetra Tech 1998
CLD3-R	Qal	12.44	Pump	Cooper & Jacob, recovery	TIMET 2007
CLD4-R	Qal	0.53	Not Available	Theis recovery	Tetra Tech 1998
CLD4-R	Qal	2.02	Not Available	Theis	Tetra Tech 1998
CLD4-R	Qal	0.97	Not Available	Neuman	Tetra Tech 1998
CMT-101	xMCf	1.23E-03	Pump	Bouwer-Rice	TIMET 2008
CMT-102	xMCf	1.87E-02	Pump	Bouwer-Rice	TIMET 2008
CMT-103	UMCf-cg	1.05E-02	Pump	Bouwer-Rice	TIMET 2008
CMT-104	UMCf	2.89E-03	Pump	Bouwer-Rice	TIMET 2008
CMT-105	UMCf-cg	5.79E-03	Pump	Bouwer-Rice	TIMET 2008
CMT-106	UMCf	4.43E-07	Pump	Bouwer-Rice	TIMET 2008
CMT-107	UMCf-cg	0.11	Pump	Bouwer-Rice	TIMET 2008
CMT-202	xMCf	0.01	Pump	Bouwer-Rice	TIMET 2008
CMT-203	UMCf-cg	1.29E-05	Pump	Bouwer-Rice	TIMET 2008
CMT-205	UMCf	2.91E-02	Pump	Bouwer-Rice	TIMET 2008
CMT-303	xMCf	3.60E-02	Pump	Bouwer-Rice	TIMET 2008
CMT-304	xMCf	4.86E-02	Pump	Bouwer-Rice	TIMET 2008
CMT-307	UMCf	1.34E-03	Pump	Bouwer-Rice	TIMET 2008
CMT-502	xMCf	0.15	Pump	Bouwer-Rice	TIMET 2008
CMT-503	xMCf	3.76E-02	Pump	Bouwer-Rice	TIMET 2008
CMT-504	xMCf	2.24E-02	Pump	Bouwer-Rice	TIMET 2008
CMT-505	UMCf	4.89E-03	Pump	Bouwer-Rice	TIMET 2008
CMT-506	UMCf	5.18E-06	Pump	Bouwer-Rice	TIMET 2008
CMT-507	UMCf	1.50E-03	Pump	Bouwer-Rice	TIMET 2008
CTIW-01D	UMCf	1.4	Slug	Bouwer-Rice	Tetra Tech 2018b
CTIW-01D	UMCf	0.86	Slug	Bouwer-Rice	Tetra Tech 2018b
CTIW-01D	UMCf	1.5	Specific Capacity	Theis (1935), Confined	Tetra Tech 2018b
CTIW-01D	UMCf	1	Specific Capacity	Theis (1935), Confined	Tetra Tech 2018b

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
CTIW-01S	Qal	61	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTIW-01S	Qal	61	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTIW-02D	UMCf	0.97	Slug	Bouwer-Rice	Tetra Tech 2018b
CTIW-02D	UMCf	0.086	Slug	Bouwer-Rice	Tetra Tech 2018b
CTIW-02D	UMCf	0.63	Specific Capacity	Theis (1935), Confined	Tetra Tech 2018b
CTIW-02S	Qal	30	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTIW-03D	UMCf	0.35	Slug	Bouwer-Rice	Tetra Tech 2018b
CTIW-03D	UMCf	0.35	Slug	Bouwer-Rice	Tetra Tech 2018b
CTIW-03D	UMCf	0.19	Specific Capacity	Theis (1935), Confined	Tetra Tech 2018b
CTIW-03S	Qal	53	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTMW-01D	UMCf	0.55	Slug	Bouwer-Rice	Tetra Tech 2018b
CTMW-01D	UMCf	0.71	Slug	Bouwer-Rice	Tetra Tech 2018b
CTMW-01D	UMCf	0.54	Specific Capacity	Theis (1935), Confined	Tetra Tech 2018b
CTMW-01S	Qal	15	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTMW-01S	Qal	0.41	Specific Capacity	Bouwer-Rice (1976)	Tetra Tech 2018b
CTMW-02D	UMCf	0.58	Slug	Bouwer-Rice	Tetra Tech 2018b
CTMW-02D	UMCf	0.51	Slug	Bouwer-Rice	Tetra Tech 2018b
CTMW-02D	UMCf	0.4	Specific Capacity	Theis (1935), Confined	Tetra Tech 2018b
CTMW-02S	Qal	27	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTMW-02S	Qal	0.51	Specific Capacity	Bouwer-Rice (1976)	Tetra Tech 2018b
CTMW-03D	UMCf	2.5	Slug	Bouwer-Rice	Tetra Tech 2018b
CTMW-03D	UMCf	3.1	Slug	Bouwer-Rice	Tetra Tech 2018b
CTMW-03D	UMCf	3	Specific Capacity	Theis (1935), Confined	Tetra Tech 2018b
CTMW-03S	Qal	75	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTMW-03S	Qal	130	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTMW-03S	Qal	120	Specific Capacity	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018b
CTMW-04D	UMCf	1.1	Slug	Bouwer-Rice	Tetra Tech 2018b

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
CTMW-04D	UMCf	1.3	Slug	Bouwer-Rice	Tetra Tech 2018b
CTMW-04D	UMCf	0.36	Specific Capacity	Theis (1935), Confined	Tetra Tech 2018b
CTMW-04S	Qal	34	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTMW-04S	Qal	23	Specific Capacity	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018b
CTMW-05D	UMCf	1.5	Slug	Bouwer-Rice	Tetra Tech 2018b
CTMW-05S	Qal	46	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTMW-05S	Qal	27	Specific Capacity	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018b
CTMW-06D	UMCf	1	Slug	Bouwer-Rice	Tetra Tech 2018b
CTMW-06S	Qal	120	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018b
CTMW-06S	Qal	91	Specific Capacity	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018b
DBMW-1	Qal/UMCf	7.85E-03	Lab	--	Kleinfelder 2007a
DBMW-1	Qal/UMCf	5.90E-03	Lab	--	Kleinfelder 2007a
DBMW-10	Qal/UMCf	4.54E-04	Lab	--	Kleinfelder 2007a
DBMW-10	Qal/UMCf	6.29E-04	Lab	--	Kleinfelder 2007a
DBMW-11	UMCf	8.39E-05	Lab	--	Kleinfelder 2007a
DBMW-11	UMCf	3.63E-05	Lab	--	Kleinfelder 2007a
DBMW-12	UMCf	2.28E-05	Lab	--	Kleinfelder 2007a
DBMW-12	UMCf	1.17E-04	Lab	--	Kleinfelder 2007a
DBMW-13	UMCf	1.07E-04	Lab	--	Kleinfelder 2007a
DBMW-13	UMCf	3.57E-05	Lab	--	Kleinfelder 2007a
DBMW-13	UMCf	8.50E-03	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-14	UMCf	1.05E-03	Lab	--	Kleinfelder 2007a
DBMW-14	UMCf	3.49E-05	Lab	--	Kleinfelder 2007a
DBMW-15	UMCf	1.24	Lab	--	Kleinfelder 2007a
DBMW-15	UMCf	0.42	Lab	--	Kleinfelder 2007a
DBMW-16	Qal/UMCf	0.87	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
DBMW-16	Qal/UMCf	0.38	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-16	Qal/UMCf	4.68E-02	Lab	--	Kleinfelder 2007a
DBMW-16	Qal/UMCf	1.35E-02	Lab	--	Kleinfelder 2007a
DBMW-17	Qal/UMCf	2.86	Lab	--	Kleinfelder 2007a
DBMW-17	Qal/UMCf	0.02	Lab	--	Kleinfelder 2007a
DBMW-17	Qal/UMCf	16	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-17	Qal/UMCf	15	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-17	Qal/UMCf	16	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-17	Qal/UMCf	18	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-18	Qal/UMCf	7.80E-03	Lab	--	Kleinfelder 2007a
DBMW-18	Qal/UMCf	6.60E-02	Lab	--	Kleinfelder 2007a
DBMW-19	Qal/UMCf	1.35	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-19	Qal/UMCf	2.75	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-19	Qal/UMCf	0.825	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-19	Qal/UMCf	2.9	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-19	Qal/UMCf	0.41	Lab	--	Kleinfelder 2007a
DBMW-19	Qal/UMCf	0.03	Lab	--	Kleinfelder 2007a
DBMW-2	Qal	0.0428	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-2	Qal	0.06	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-2	Qal	0.004	Lab	--	Kleinfelder 2007a
DBMW-2	Qal	0.018	Lab	--	Kleinfelder 2007a
DBMW-20	Qal/UMCf	0.045	Lab	--	Kleinfelder 2007a
DBMW-20	Qal/UMCf	0.451	Lab	--	Kleinfelder 2007a
DBMW-22	UMCf	0.0625	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-22	UMCf	0.0801	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-22	UMCf	0.005	Lab	--	Kleinfelder 2007a
DBMW-22	UMCf	0.003	Lab	--	Kleinfelder 2007a
DBMW-3	Qal/UMCf	0.011	Lab	--	Kleinfelder 2007a

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
DBMW-3	Qal/UMCf	0.004	Lab	--	Kleinfelder 2007a
DBMW-3	Qal/UMCf	0.23	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-4	Qal/UMCf	2	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-4	Qal/UMCf	2.1	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-4	Qal/UMCf	1.9	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-4	Qal/UMCf	2	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-4	Qal/UMCf	0.04	Lab	--	Kleinfelder 2007a
DBMW-4	Qal/UMCf	1.20	Lab	--	Kleinfelder 2007a
DBMW-4	Qal/UMCf	6.6	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-4	Qal/UMCf	7	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-4	Qal/UMCf	6.9	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-4	Qal/UMCf	6.6	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-5	UMCf	4.90E-02	Lab	--	Kleinfelder 2007a
DBMW-5	UMCf	6.63E-04	Lab	--	Kleinfelder 2007a
DBMW-6	Qal/UMCf	1.71E-04	Lab	--	Kleinfelder 2007a
DBMW-6	Qal/UMCf	2.63E-02	Lab	--	Kleinfelder 2007a
DBMW-7	UMCf	2.70E-04	Lab	--	Kleinfelder 2007a
DBMW-7	UMCf	3.37E-05	Lab	--	Kleinfelder 2007a
DBMW-7	UMCf	2.8	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-7	UMCf	2.8	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-8	UMCf	0.5	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-8	UMCf	0.59	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-8	UMCf	0.516	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-8	UMCf	0.59	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-8	UMCf	2.86E-03	Lab	--	Kleinfelder 2007a
DBMW-8	UMCf	2.86E-04	Lab	--	Kleinfelder 2007a
DBMW-8	UMCf	1	Slug	Zlotnick, Goss and Dufield (2010)	[2]
DBMW-9	UMCf	0.08	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
DBMW-9	UMCf	0.079	Slug	Bouwer and Rice, 1976	Wittman G.P. and Carter G.A. 2007
DBMW-9	UMCf	5.56E-05	Lab	--	Kleinfelder 2007a
DBMW-9	UMCf	3.03E-04	Lab	--	Kleinfelder 2007a
DW	Wash Gravels	497	Not Available	Cooper-Jacob Time-Drawdown, AquiferTest Software	Converse Consultants 2002
DW	Wash Gravels	328	Not Available	Cooper-Jacob Time-Drawdown, Graphical Calculation	Converse Consultants 2002
DW	Wash Gravels	1742	Not Available	Theis-Residual Drawdown, AquiferTest Software	Converse Consultants 2002
DX-161A	UMCf-cg	--	Pump test (pump from DX-161)	--	AMPAC 2011a
DX-161C	UMCf-cg	--	Pump test (pump from DX-161)	--	AMPAC 2011a
E1-1	Qal/UMCf	2	Slug	Bouwer-Rice	Tetra Tech 2018a
E1-2	Qal/UMCf	0.55	Slug	Bouwer-Rice	Tetra Tech 2018a
E1-3	Qal/UMCf	0.45	Slug	Bouwer-Rice	Tetra Tech 2018a
E2-1	Qal/UMCf	2	Slug	Bouwer-Rice	Tetra Tech 2018a
E2-2	Qal/UMCf	2.3	Slug	Bouwer-Rice	Tetra Tech 2018a
E2-3	Qal/UMCf	3.7	Slug	Bouwer-Rice	Tetra Tech 2018a
E2-4	Qal/UMCf	2.7	Slug	Bouwer-Rice	Tetra Tech 2018a
E2-5	Qal/UMCf	0.71	Slug	Bouwer-Rice	Tetra Tech 2018a
EC-1	Qal/UMCf	0.652	Slug	Bouwer-Rice	Kleinfelder 2008
EC-1	Qal/UMCf	0.65	Slug	Bouwer-Rice	Kleinfelder 2008
EC-1	Qal/UMCf	0.608	Slug	Bouwer-Rice	Kleinfelder 2008
EC-1	Qal/UMCf	0.68	Slug	Bouwer-Rice	Kleinfelder 2008
ES-1	UMCf	0.13	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-10	UMCf	0.006	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-11	UMCf	0.084	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-12	UMCf	1.9	Slug	Zlotnick, Goss and Dufield (2010)	[2]

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
ES-12	UMCf	1.8	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-12	UMCf	1.7	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-12	UMCf	1.6	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-13	UMCf	0.0029	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-13	UMCf	0.001	Slug	Bouwer-Rice	Tetra Tech 2019a
ES-19	UMCf	0.087	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-2	Qal/UMCf	10	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-2	Qal/UMCf	8.9	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-2	Qal/UMCf	8.5	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-2	Qal/UMCf	9.4	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-20	UMCf	0.19	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-21A	UMCf	0.38	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-21B	UMCf	3.2	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-21B	UMCf	3.1	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-21B	UMCf	2.8	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-21B	UMCf	3.3	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-21B	UMCf	2.7	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-21B	UMCf	2.5	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-21B	UMCf	2.3	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-21B	UMCf	2.7	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-22A	UMCf	3.4	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-22A	UMCf	3.9	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-22A	UMCf	3.2	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-22A	UMCf	3.4	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-22B	UMCf	0.065	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-23A	UMCf	0.52	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-23A	UMCf	0.49	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-23B	UMCf	0.09	Slug	Zlotnick, Goss and Dufield (2010)	[2]

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
ES-24	UMCf	0.012	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-25A	UMCf	0.2	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-25A	UMCf	0.072	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-26	UMCf	0.58	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-26	UMCf	0.58	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-26	UMCf	0.53	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-26	UMCf	0.53	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-27	Qal	0.26	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-27	Qal	0.3	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-28	UMCf	3	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-28	UMCf	3.2	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-28	UMCf	3	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-28	UMCf	3	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-29	UMCf	1.1	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-29	UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-29	UMCf	1.1	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-29	UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-3	Qal	7.6	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-3	Qal	7.6	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-3	Qal	8.6	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-3	Qal	8.7	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-30	UMCf	0.4	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-30	UMCf	0.36	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-31	UMCf	3.6	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-31	UMCf	2.7	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-31	UMCf	2.6	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-31	UMCf	2.8	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-32	UMCf	0.046	Slug	Zlotnick, Goss and Dufield (2010)	[2]

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
ES-4	UMCf	0.097	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-5	UMCf	0.017	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-6	UMCf	0.91	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-6	UMCf	0.89	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-6	UMCf	0.91	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-6	UMCf	0.97	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-7	UMCf	0.0049	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-8A	UMCf	0.54	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-8A	UMCf	0.48	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-8B	UMCf	0.37	Slug	Zlotnick, Goss and Dufield (2010)	[2]
ES-8B	UMCf	0.32	Slug	Zlotnick, Goss and Dufield (2010)	[2]
EW-2	UMCf-cg	--	Pump test (pump from DX-161)	--	AMPAC 2011a
GRTS-MW01A	UMCf	1.4	Slug	Bouwer-Rice	Tetra Tech 2019a
GRTS-MW01B	UMCf	0.0036	Slug	Bouwer-Rice	Tetra Tech 2019a
GRTS-MW02A	UMCf	0.0015	Slug	Bouwer-Rice	Tetra Tech 2019a
GRTS-MW02B	UMCf	0.0017	Slug	Bouwer-Rice	Tetra Tech 2019a
GRTS-MW03A	UMCf	1.1	Slug	Bouwer-Rice	Tetra Tech 2019a
GRTS-MW03B	UMCf	0.0022	Slug	Bouwer-Rice	Tetra Tech 2019a
GRTS-MW04A	UMCf	0.085	Slug	Bouwer-Rice	Tetra Tech 2019a
GRTS-MW04B	UMCf	0.0024	Slug	Bouwer-Rice	Tetra Tech 2019a
GRTS-MW05A	UMCf	0.057	Slug	Bouwer-Rice	Tetra Tech 2019a
GRTS-MW05B	UMCf	0.014	Slug	Bouwer-Rice	Tetra Tech 2019a
H-10	Qal/xMCF	2.4	Step	--	Stauffer 1983
H-10	Qal/xMCF	2.8	Slug	--	Stauffer 1983
H-14	Paleochannels	45.5	Step	--	Geraghty & Miller, Inc. 1980
H-14	Paleochannels	109.6	Step	Theis H-37 obs well	Geraghty & Miller, Inc. 1980
H-17	Paleochannels	78.9	Step	--	Stauffer 1983

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
H-18	Paleochannels	618.3	Step	--	Geraghty & Miller, Inc. 1980
H-19	Qal/UMCf	22.1	Step	--	Geraghty & Miller, Inc. 1980
H-19	Qal/UMCf	382.3	Step	Theis H-46 obs well	Geraghty & Miller, Inc. 1980
H-21R	Qal	129.4	Pump	--	Geraghty & Miller, Inc. 1980
H-36	Qal	235.3	Pump	Boulton	Stauffer 1983
H-36	Qal	244.6	Step	Jacob	Stauffer 1983
H-43	Qal	300.8	Step	--	Stauffer 1983
H-48	Paleochannels	320.8	Pump	--	Batista, J.R., et al. 2003
H-49A	Paleochannels	83.8	Step	--	Stauffer 1983
H-51	Paleochannels	80.7	Step	--	Stauffer 1983
H-52	Qal	9.2	Slug	--	Stauffer 1983
H-52	Qal	15.37326282	Slug	--	Stauffer 1983
H-53	Paleochannels	135.6857545	Pump	Boulton	Stauffer 1983
H-53	Paleochannels	125.0	Step	Jacob	Stauffer 1983
H-54	Paleochannels	129.7	Pump	Boulton	Stauffer 1983
H-54	Paleochannels	235.3	Step	Jacob	Stauffer 1983
H-54	Paleochannels	116.3	Step	Jacob	Stauffer 1983
I-AA	Qal/UMCf	300	Step	Moench	Ramboll Environ 2013
I-AB	Qal/UMCf	0.2	Step	Moench	Ramboll Environ 2013
I-AC	Qal/UMCf	0.03	Step	Moench	Ramboll Environ 2013
I-AD	Qal/UMCf	1.2	Step	Moench	Ramboll Environ 2013
I-B	xMCf/UMCf	0.7	Pump	Moench	Ramboll Environ 2013
I-D	Paleochannels	220	Pump	Moench	Ramboll Environ 2013
I-G	UMCf	0.6	Pump	Moench	Ramboll Environ 2013
I-J	UMCf	5.3	Pump	Moench	Ramboll Environ 2013
I-K	UMCf	4.8	Pump	Moench	Ramboll Environ 2013
I-N	Paleochannels	28	Pump	Moench	Ramboll Environ 2013
I-V	Qal	55	Pump	Moench	Ramboll Environ 2013

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
I-W	Qal	4.2	Step	Moench	Ramboll Environ 2013
IW-1	Wash Gravels	1.34	Slug	--	Converse Consultants 2006a
IW-1	Wash Gravels	6.21	Slug	--	Converse Consultants 2006a
IW-1	Wash Gravels	1.34	Slug	--	GES 2005a
IW-1	Wash Gravels	6.21	Slug	--	GES 2005a
IW-2	Wash Gravels	1.84	Slug	--	Converse Consultants 2006a
IW-2	Wash Gravels	0.17	Slug	--	Converse Consultants 2006a
IW-2	Wash Gravels	1.84	Slug	--	GES 2005a
IW-2	Wash Gravels	0.17	Slug	--	GES 2005a
IW-2	Wash Gravels	0.07	Slug	--	GES 2003
IW-2	Wash Gravels	0.06	Slug	--	GES 2003
IW-3	Wash Gravels	2.86	Slug	--	Converse Consultants 2006a
IW-3	Wash Gravels	2.86	Slug	--	GES 2005a
I-X	Paleochannels	9.7	Step	Moench	Ramboll Environ 2013
I-Y	Qal	3.8	Step	Moench	Ramboll Environ 2013
J2D1-R	Qal	2.6477	Not Available	Theis recovery	Tetra Tech 1998
J2D2-R2	Qal	125.1477454	Pump	Cooper & Jacob, recovery	TIMET 2007
J2D2-R2	Qal	14.545	Not Available	Theis recovery	Tetra Tech 1998
J2D2-R2	Qal	50.775	Not Available	Cooper-Jacob	Tetra Tech 1998
J2D2-R2	Qal	74	Not Available	Theis	Tetra Tech 1998
LVWPS-MW101A	Qal	22	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW101B	UMCf	1.6	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW102A	UMCf	3.5	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW102B	UMCf	1	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW103A	UMCf	0.36	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW104	Qal	2.9	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW105	Qal	3.9	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW106	UMCf	1.3	Slug	Bouwer-Rice	Tetra Tech 2019b

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
LVWPS-MW107A	Qal	85	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW107B	UMCf	0.02	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW107C	UMCf	1.4	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW108A	Qal	15	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW108B	UMCf	4.5	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW108C	UMCf	0.045	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW109	Qal	22	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW110	UMCf	0.21	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW111A	Qal	2.5	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW111B	UMCf	1.9	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW112A	Paleochannels	72	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW112B	UMCf	0.0013	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW201A	Wash Gravels	20	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW201B	UMCf	4.1	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW202	Wash Gravels	96	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW203A	Wash Gravels	83	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW203B	UMCf	0.087	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW204	Wash Gravels	88	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW204B	UMCf	0.34	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW205B	Wash Gravels	110	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW205C	Wash Gravels	79	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW206A	Wash Gravels	83	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW206B	Wash Gravels	190	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW206C	UMCf	3.9	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW206D	UMCf	0.37	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW206E	UMCf	0.31	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW207	Wash Gravels	89	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW208A	Wash Gravels	200	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
LVWPS-MW208B	Wash Gravels	60	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW209	Wash Gravels	83	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW209A	Wash Gravels	420	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW209B	UMCf-cg	38	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW209C	UMCf-cg	9.2	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW210A	Wash Gravels	79	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW210B	Wash Gravels	88	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW210C	UMCf-cg	0.23	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW210D	UMCf-cg	0.31	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW210E	UMCf-cg	0.42	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW211	Wash Gravels	95	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW212A	Wash Gravels	72	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW212B	Wash Gravels	9.8	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW212C	UMCf-cg	4	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW212D	UMCf-cg	0.73	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW213	Wash Gravels	90	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW214	Wash Gravels	140	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW215A	Wash Gravels	54	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW215B	UMCf/Horse Springs	0.41	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW216	Wash Gravels	6.1	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW217A	Wash Gravels	100	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW217B	UMCf	0.92	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW217C	UMCf	0.4	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW218A	Wash Gravels	83	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW218B	UMCf	3.3	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW218C	UMCf	2.6	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW219A	Wash Gravels	120	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW219B	UMCf/Horse Springs	1.9	Slug	Bouwer-Rice	Tetra Tech 2019b

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
LVWPS-MW219C	UMCf/Horse Springs	10	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW220A	Wash Gravels	79	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW220B	UMCf-cg	7.2	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW221A	Wash Gravels	9.1	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW221B	UMCf	0.12	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW222A	UMCf	5.7	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW222B	UMCf-cg	0.45	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW222C	UMCf-cg	0.37	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW223A	Wash Gravels	50	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW223B	Wash Gravels	79	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW223C	UMCf	0.52	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW224A	Qal	22	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW224B	UMCf	1	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW224C	UMCf	0.073	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW225A	Qal	110	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LVWPS-MW225B	UMCf	1.3	Slug	Bouwer-Rice	Tetra Tech 2019b
LVWPS-MW226A	Qal	89	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
LX-150	UMCf-cg	273.2	Slug	Bouwer-Rice	Geosyntec 2010
LX-150	UMCf-cg	241.7	Slug	Bouwer-Rice	Geosyntec 2010
LX-150	UMCf-cg	280.3	Slug	Bouwer-Rice	Geosyntec 2010
M-11	UMCf	1.14	Pump	Jacob drawdown	KMCC 1985
M-11	UMCf	0.87	Slug	Bouwer and Rice, 1976	KMCC 1985
M-117	UMCf	0.01026	Slug	--	Ramboll Environ 2016
M-117	UMCf	0.01207	Slug	--	Ramboll Environ 2016
M-118	UMCf	0.04727	Slug	--	Ramboll Environ 2016
M-118	UMCf	0.05042	Slug	--	Ramboll Environ 2016
M-12	UMCf	2.57	Slug	Bouwer and Rice, 1976	KMCC 1985
M-125D	UMCf	1.8	Slug	Zlotnick, Goss and Dufield (2010)	[1]

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Nevada Environmental Response Trust Site
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
M-125D	UMCf	1.5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-129	Qal/UMCf	2.98E-03	Lab	--	Crowley Environmental 2009
M-13	UMCf	4.83	Slug	Bouwer and Rice, 1976	KMCC 1985
M-130	UMCf	0.00272126	Lab	--	Crowley Environmental 2009
M-132	UMCf	0.008135433	Lab	--	Crowley Environmental 2009
M-136	UMCf	8.25E-03	Lab	--	Crowley Environmental 2009
M-140D	UMCf	5.60E-02	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-149	UMCf	7.53E-03	Slug	--	Ramboll Environ 2016
M-149	UMCf	8.33E-03	Slug	--	Ramboll Environ 2016
M-14D	UMCf	1.3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-14D	UMCf	0.6	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-15	Paleochannels	40.9	Slug	Bouwer and Rice, 1976	KMCC 1985
M-150	UMCf	1.19E-03	Slug	--	Ramboll Environ 2016
M-150	UMCf	1.14E-03	Slug	--	Ramboll Environ 2016
M-151	UMCf	1.77E-03	Slug	--	Ramboll Environ 2016
M-151	UMCf	2.07E-03	Slug	--	Ramboll Environ 2016
M-152	UMCf	5.78E-02	Slug	--	Ramboll Environ 2016
M-152	UMCf	6.23E-02	Slug	--	Ramboll Environ 2016
M-153	UMCf	1.42E-03	Slug	--	Ramboll Environ 2016
M-153	UMCf	1.35E-03	Slug	--	Ramboll Environ 2016
M-154	UMCf	2.19E-03	Slug	--	Ramboll Environ 2016
M-154	UMCf	2.29E-03	Slug	--	Ramboll Environ 2016
M-156	UMCf	9.30E-04	Slug	--	Ramboll Environ 2016
M-161	UMCf	1.17E-02	Slug	--	Ramboll Environ 2016
M-161	UMCf	8.25E-03	Slug	--	Ramboll Environ 2016
M-161D	UMCf	2.43E-02	Slug	--	Ramboll Environ 2016
M-161D	UMCf	2.79E-02	Slug	--	Ramboll Environ 2016
M-162	UMCf	0.11	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
M-162	UMCf	0.12	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-162	UMCf	0.12	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-162	UMCf	9.65E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-162	UMCf	8.68E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-162	UMCf	3.69E-02	Slug	avg of Hvorsleve & Bouwer Rice	Tronox 2010
M-162	UMCf	0.11	Pump	--	Ramboll Environ 2016
M-162	UMCf	0.12	Slug	--	Ramboll Environ 2016
M-162	UMCf	0.12	Slug	--	Ramboll Environ 2016
M-162	UMCf	0.096	Slug	--	Ramboll Environ 2016
M-162	UMCf	0.087	Slug	--	Ramboll Environ 2016
M-162	UMCf	3.70E-02	Slug	--	Ramboll Environ 2016
M-162D	UMCf	8.60E-02	Slug	--	Ramboll Environ 2016
M-162D	UMCf	2.20E-03	Slug	--	Ramboll Environ 2016
M-163	UMCf	5.04E-03	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-163	UMCf	4.10E-03	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-164	UMCf	7.12E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-164	UMCf	9.60E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-164	UMCf	6.31E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-164	UMCf	7.27E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-164	UMCf	7.87E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-164	UMCf	7.77E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-17	Qal/UMCf	24.3	Slug	Bouwer and Rice, 1976	KMCC 1985
M-181	UMCf	0.21	Slug	--	Ramboll Environ 2016
M-181	UMCf	0.23	Slug	--	Ramboll Environ 2016
M-181	UMCf	0.24	Slug	--	Ramboll Environ 2016
M-181	UMCf	0.22	Slug	--	Ramboll Environ 2016
M-186	UMCf	0.23	Slug	--	Ramboll Environ 2016
M-186	UMCf	0.21	Slug	--	Ramboll Environ 2016

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
M-186	UMCf	0.26	Slug	--	Ramboll Environ 2016
M-186	UMCf	0.22	Slug	--	Ramboll Environ 2016
M-186D	UMCf	5.06E-03	Slug	--	Ramboll Environ 2016
M-187	UMCf	8.28E-03	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-187	UMCf	3.67E-03	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-187	UMCf	1.36E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-187	UMCf	6.48E-03	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-187	UMCf	1.06E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-187	UMCf	1.54E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-187	UMCf	8.98E-03	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-188	UMCf	6.84E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-188	UMCf	8.28E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-188	UMCf	2.77E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-188	UMCf	0.0432	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-188	UMCf	0.0696	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-188	UMCf	7.99E-02	Slug	avg of Hvorslev & Bouwer Rice	Tronox 2010
M-195	UMCf	7.60E-02	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-196	UMCf	3.50E-02	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-197	UMCf	0.1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-198	UMCf	0.015	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-199	UMCf	0.11	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-2	Paleochannels	41.8	Slug	Bouwer and Rice, 1976	KMCC 1985
M-2	Paleochannels	60.6	Pump	Jacob drawdown	KMCC 1985
M-200	UMCf	0.69	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-200	UMCf	0.75	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-200	UMCf	0.69	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-200	UMCf	0.65	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-201	UMCf	4.3	Slug	Zlotnick, Goss and Dufield (2010)	[1]

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
M-201	UMCf	5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-201	UMCf	3.9	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-201	UMCf	5.5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-202	UMCf	1.5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-202	UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-202	UMCf	1.4	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-202	UMCf	1.3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-203	UMCf	0.73	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-203	UMCf	0.8	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-203	UMCf	0.74	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-203	UMCf	0.77	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-204	UMCf	0.0032	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-205	UMCf	0.93	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-205	UMCf	0.94	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-205	UMCf	0.91	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-205	UMCf	0.93	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-206	UMCf	3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-206	UMCf	3.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-206	UMCf	3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-206	UMCf	2.7	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-207	Qal/UMCf	21	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-207	Qal/UMCf	51	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-207	Qal/UMCf	18	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-207	Qal/UMCf	43	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-207	Qal/UMCf	150	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-207	Qal/UMCf	40	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-207	Qal/UMCf	54	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-207	Qal/UMCf	48	Slug	Zlotnick, Goss and Dufield (2010)	[1]

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
M-208	Paleochannels	0.6	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-209	UMCf	0.23	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-210	UMCf	0.052	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-211	Qal/UMCf	1.1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-211	Qal/UMCf	1.4	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-212	UMCf	0.12	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-213	UMCf	0.043	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-215	UMCf	0.29	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-216	UMCf	0.83	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-217	UMCf	0.066	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-218	UMCf	0.016	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-219	UMCf	0.053	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-21D	UMCf	3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-21D	UMCf	3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-21D	UMCf	3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-21D	UMCf	3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-21D	UMCf	3.3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-21D	UMCf	3.3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-21D	UMCf	3.4	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-21D	UMCf	3.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-220	UMCf	0.066	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-221	UMCf	0.15	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-222	UMCf	0.01	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-223	UMCf	5.7	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-223	UMCf	5.8	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-223	UMCf	5.9	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-223	UMCf	5.7	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-225	UMCf	0.0066	Slug	Zlotnick, Goss and Dufield (2010)	[1]

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
M-226	UMCf	5.5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-226	UMCf	5.4	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-226	UMCf	5.6	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-226	UMCf	5.4	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-226	UMCf	5.3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-227	UMCf	0.93	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-227	UMCf	0.99	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-227	UMCf	1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-227	UMCf	0.9	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-229	UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-229	UMCf	1.3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-22D	UMCf	0.11	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-230	UMCf	0.038	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-231	UMCf	0.003	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-232	UMCf	0.02	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-233	UMCf	0.026	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-234	UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-234	UMCf	1.3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-234	UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-234	UMCf	1.3	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-235	UMCf	0.075	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-236	UMCf	0.25	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-237	UMCf	6	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-237	UMCf	6.1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-237	UMCf	5.6	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-237	UMCf	6.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-238	UMCf	0.59	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-238	UMCf	0.53	Slug	Zlotnick, Goss and Dufield (2010)	[1]

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
M-239	UMCf	1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-239	UMCf	1.1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-239	UMCf	1.1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-239	UMCf	1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-239	UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-239	UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-239	UMCf	1.1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-239	UMCf	1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-240	UMCf	2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-240	UMCf	2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-240	UMCf	1.9	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-240	UMCf	1.9	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-242	UMCf	0.51	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-242	UMCf	0.5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-243	UMCf	0.32	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-244	UMCf	0.045	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-244	UMCf	0.023	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-245	UMCf	0.73	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-245	UMCf	0.68	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-246	UMCf	0.92	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-251-100	UMCf	0.061	Slug	Bouwer-Rice	Tetra Tech 2019c
M-251-100	UMCf	0.062	Slug	Bouwer-Rice	Tetra Tech 2019c
M-251-60	UMCf	0.03	Slug	Bouwer-Rice	Tetra Tech 2019c
M-251-60	UMCf	0.03	Slug	Bouwer-Rice	Tetra Tech 2019c
M-252	UMCf	0.039	Slug	Bouwer-Rice	Tetra Tech 2019c
M-252	UMCf	0.041	Slug	Bouwer-Rice	Tetra Tech 2019c
M-253-100	UMCf	0.0061	Slug	Bouwer-Rice	Tetra Tech 2019c
M-253-100	UMCf	0.0054	Slug	Bouwer-Rice	Tetra Tech 2019c

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
M-253-60	UMCf	0.57	Slug	Bouwer-Rice	Tetra Tech 2019c
M-253-60	UMCf	0.58	Slug	Bouwer-Rice	Tetra Tech 2019c
M-254	UMCf	0.023	Slug	Bouwer-Rice	Tetra Tech 2019c
M-254	UMCf	0.015	Slug	Bouwer-Rice	Tetra Tech 2019c
M-255-100	UMCf	0.028	Slug	Bouwer-Rice	Tetra Tech 2019c
M-255-100	UMCf	0.018	Slug	Bouwer-Rice	Tetra Tech 2019c
M-255-60	UMCf	0.52	Slug	Bouwer-Rice	Tetra Tech 2019c
M-255-60	UMCf	0.59	Slug	Bouwer-Rice	Tetra Tech 2019c
M-256-100	UMCf	0.043	Slug	Bouwer-Rice	Tetra Tech 2019c
M-256-100	UMCf	0.025	Slug	Bouwer-Rice	Tetra Tech 2019c
M-256-60	UMCf	0.066	Slug	Bouwer-Rice	Tetra Tech 2019c
M-256-60	UMCf	0.064	Slug	Bouwer-Rice	Tetra Tech 2019c
M-260	UMCf	0.58	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-260	UMCf	0.57	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-261	UMCf	0.091	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-262	UMCf	0.022	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-263	UMCf	0.22	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-264	UMCf	0.017	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-265	UMCf	0.023	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-266	UMCf	0.0015	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-267	UMCf	0.06	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-268	UMCf	0.037	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-269	UMCf	0.081	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-27	Paleochannels	199.99	Slug	Bouwer and Rice, 1976	KMCC 1985
M-270	UMCf	0.011	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-271	UMCf	0.0034	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-3	Paleochannels	131.41	Slug	Bouwer and Rice, 1976	KMCC 1985
M-36D	UMCf	1.4	Slug	Zlotnick, Goss and Dufield (2010)	[1]

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
M-36D	UMCf	1.5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-36D	UMCf	1.5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-36D	UMCf	1.6	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-36D	UMCf	1.9	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-36D	UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-36D	UMCf	0.82	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-36D	UMCf	2.7	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-39R	Qal/UMCf	8	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-39R	Qal/UMCf	6.7	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-39R	Qal/UMCf	7.8	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-39R	Qal/UMCf	7.8	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-39R	Qal/UMCf	13	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-39R	Qal/UMCf	17	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-4	Qal	6.71	Slug	Bouwer and Rice, 1976	KMCC 1985
M-5D	UMCf	0.39	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-65D	UMCf	0.059	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-66D	UMCf	0.22	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-72D	UMCf	0.12	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-8	Qal	111.49	Slug	Bouwer and Rice, 1976	KMCC 1985
M-81D	UMCf	0.24	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-83D	UMCf	0.036	Slug	Zlotnick, Goss and Dufield (2010)	[1]
M-9	Paleochannels	7.29	Slug	Bouwer and Rice, 1976	KMCC 1985
MC-21	Qal/UMCf	50.80	Slug	--	Stauffer 1983
MC-25	Qal/UMCf	6.15	Slug	--	Stauffer 1983
MC-32	Qal	4.28	Slug	--	Stauffer 1983
MCF-03B	UMCf	0.18	Slug	Bouwer-Rice	Kleinfelder 2007b
MCF-06B	UMCf	0.0028	Slug	Bouwer-Rice	Tetra Tech 2019a
MCF-06C	UMCf	1.5	Slug	Bouwer-Rice	Kleinfelder 2007b

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
MCF-16C	Qal/UMCf	0.24	Slug	Bouwer-Rice	Kleinfelder 2007b
MCF-24B	UMCf	0.005	Slug	Hvorslev	Converse Consultants 2009
MCF-24B	UMCf	0.006	Slug	Bouwer and Rice	Converse Consultants 2009
MCF-24B	UMCf	0.00161	Slug	Hvorslev	Converse Consultants 2009
MCF-24B	UMCf	0.00154	Slug	Bouwer Rice	Converse Consultants 2009
MCF-24B	UMCf	0.0101	Slug	Hvorslev	Converse Consultants 2009
MCF-24B	UMCf	0.0136	Slug	Bouwer Rice	Converse Consultants 2009
MCF-24B	UMCf	0.00336	Slug	Hvorslev	Converse Consultants 2009
MCF-24B	UMCf	0.00322	Slug	Bouwer Rice	Converse Consultants 2009
MCF-24B	UMCf	0.0606	Slug	Hvorslev	Converse Consultants 2009
MCF-24B	UMCf	0.0818	Slug	Bouwer Rice	Converse Consultants 2009
MCF-28A	UMCf	4.00E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-28A	UMCf	4.00E-03	Slug	Bouwer and Rice	Converse Consultants 2009
MCF-28A	UMCf	3.77E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-28A	UMCf	4.03E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-28A	UMCf	0.00114	Slug	Hvorslev	Converse Consultants 2009
MCF-28A	UMCf	0.00121	Slug	Bouwer Rice	Converse Consultants 2009
MCF-28A	UMCf	7.33E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-28A	UMCf	7.84E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-28A	UMCf	3.19E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-28A	UMCf	3.40E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-28B	UMCf	0.044	Slug	Hvorslev	Converse Consultants 2009
MCF-28B	UMCf	0.043	Slug	Bouwer and Rice	Converse Consultants 2009
MCF-28B	UMCf	0.131	Slug	Hvorslev	Converse Consultants 2009
MCF-28B	UMCf	0.128	Slug	Bouwer Rice	Converse Consultants 2009
MCF-28B	UMCf	0.00124	Slug	Hvorslev	Converse Consultants 2009
MCF-28B	UMCf	0.00124	Slug	Bouwer Rice	Converse Consultants 2009
MCF-28B	UMCf	0.0741	Slug	Hvorslev	Converse Consultants 2009

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
MCF-28B	UMCf	0.0723	Slug	Bouwer Rice	Converse Consultants 2009
MCF-28B	UMCf	0.0132	Slug	Hvorslev	Converse Consultants 2009
MCF-28B	UMCf	0.0129	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29A	UMCf	0.103	Slug	Hvorslev	Converse Consultants 2009
MCF-29A	UMCf	0.100	Slug	Bouwer and Rice	Converse Consultants 2009
MCF-29A	UMCf	0.11	Slug	Hvorslev	Converse Consultants 2009
MCF-29A	UMCf	0.0818	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29A	UMCf	0.0818	Slug	Hvorslev	Converse Consultants 2009
MCF-29A	UMCf	0.0606	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29A	UMCf	0.0818	Slug	Hvorslev	Converse Consultants 2009
MCF-29A	UMCf	0.0606	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29A	UMCf	0.0606	Slug	Hvorslev	Converse Consultants 2009
MCF-29A	UMCf	0.0449	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29A	UMCf	0.0818	Slug	Hvorslev	Converse Consultants 2009
MCF-29A	UMCf	0.0818	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29A	UMCf	0.201	Slug	Hvorslev	Converse Consultants 2009
MCF-29A	UMCf	0.271	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29B	UMCf	0.021	Slug	Hvorslev	Converse Consultants 2009
MCF-29B	UMCf	0.02	Slug	Bouwer and Rice	Converse Consultants 2009
MCF-29B	UMCf	2.43E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-29B	UMCf	0.0025	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29B	UMCf	0.000917	Slug	Hvorslev	Converse Consultants 2009
MCF-29B	UMCf	9.17E-04	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29B	UMCf	3.86E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-29B	UMCf	3.97E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29B	UMCf	1.82E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-29B	UMCf	1.87E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29B	UMCf	0.0333	Slug	Hvorslev	Converse Consultants 2009

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
MCF-29B	UMCf	0.0183	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29B	UMCf	0.0247	Slug	Hvorslev	Converse Consultants 2009
MCF-29B	UMCf	0.0333	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29B	UMCf	3.74E-04	Slug	Hvorslev	Converse Consultants 2009
MCF-29B	UMCf	0.00167	Slug	Bouwer Rice	Converse Consultants 2009
MCF-29B	UMCf	0.0606	Slug	Hvorslev	Converse Consultants 2009
MCF-29B	UMCf	0.0818	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30A	UMCf	0.032	Slug	Hvorslev	Converse Consultants 2009
MCF-30A	UMCf	0.034	Slug	Bouwer and Rice	Converse Consultants 2009
MCF-30A	UMCf	0.0183	Slug	Hvorslev	Converse Consultants 2009
MCF-30A	UMCf	0.0183	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30A	UMCf	0.0818	Slug	Hvorslev	Converse Consultants 2009
MCF-30A	UMCf	0.0818	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30A	UMCf	0.0183	Slug	Hvorslev	Converse Consultants 2009
MCF-30A	UMCf	0.0247	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30A	UMCf	0.11	Slug	Hvorslev	Converse Consultants 2009
MCF-30A	UMCf	0.11	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30A	UMCf	0.0247	Slug	Hvorslev	Converse Consultants 2009
MCF-30A	UMCf	0.0183	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30A	UMCf	0.0183	Slug	Hvorslev	Converse Consultants 2009
MCF-30A	UMCf	0.0247	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30B	UMCf	0.03	Slug	Hvorslev	Converse Consultants 2009
MCF-30B	UMCf	0.029	Slug	Bouwer and Rice	Converse Consultants 2009
MCF-30B	UMCf	0.0148	Slug	Hvorslev	Converse Consultants 2009
MCF-30B	UMCf	0.0143	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30B	UMCf	0.11	Slug	Hvorslev	Converse Consultants 2009
MCF-30B	UMCf	0.11	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30B	UMCf	3.23E-02	Slug	Hvorslev	Converse Consultants 2009

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
MCF-30B	UMCf	3.12E-02	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30B	UMCf	6.06E-02	Slug	Hvorslev	Converse Consultants 2009
MCF-30B	UMCf	6.06E-02	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30B	UMCf	1.83E-02	Slug	Hvorslev	Converse Consultants 2009
MCF-30B	UMCf	1.01E-02	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30B	UMCf	1.01E-02	Slug	Hvorslev	Converse Consultants 2009
MCF-30B	UMCf	1.36E-02	Slug	Bouwer Rice	Converse Consultants 2009
MCF-30B	UMCf	4.49E-02	Slug	Hvorslev	Converse Consultants 2009
MCF-30B	UMCf	4.49E-02	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31A	UMCf	5.00E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-31A	UMCf	5.00E-03	Slug	Bouwer and Rice	Converse Consultants 2009
MCF-31A	UMCf	6.06E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-31A	UMCf	6.53E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31A	UMCf	2.76E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-31A	UMCf	2.97E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31A	UMCf	8.63E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-31A	UMCf	9.29E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31A	UMCf	2.63E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-31A	UMCf	2.83E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31A	UMCf	2.47E-02	Slug	Hvorslev	Converse Consultants 2009
MCF-31A	UMCf	2.47E-02	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31A	UMCf	3.60E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-31A	UMCf	3.57E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31B	UMCf	7.00E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-31B	UMCf	9.00E-03	Slug	Bouwer and Rice	Converse Consultants 2009
MCF-31B	UMCf	0.0101	Slug	Hvorslev	Converse Consultants 2009
MCF-31B	UMCf	0.015	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31B	UMCf	5.30E-03	Slug	Hvorslev	Converse Consultants 2009

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
MCF-31B	UMCf	5.42E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31B	UMCf	0.01	Slug	Hvorslev	Converse Consultants 2009
MCF-31B	UMCf	0.0103	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31B	UMCf	0.0068	Slug	Hvorslev	Converse Consultants 2009
MCF-31B	UMCf	6.95E-03	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31B	UMCf	1.24E-03	Slug	Hvorslev	Converse Consultants 2009
MCF-31B	UMCf	9.17E-04	Slug	Bouwer Rice	Converse Consultants 2009
MCF-31B	UMCf	0.0606	Slug	Hvorslev	Converse Consultants 2009
MCF-31B	UMCf	0.0606	Slug	Bouwer Rice	Converse Consultants 2009
MCF-32B	UMCf	0.077	Slug	Hvorslev	Converse Consultants 2009
MCF-32B	UMCf	0.076	Slug	Bouwer and Rice	Converse Consultants 2009
MCF-32B	UMCf	0.0818	Slug	Hvorslev	Converse Consultants 2009
MCF-32B	UMCf	0.0763	Slug	Bouwer Rice	Converse Consultants 2009
MCF-32B	UMCf	0.11	Slug	Hvorslev	Converse Consultants 2009
MCF-32B	UMCf	0.0818	Slug	Bouwer Rice	Converse Consultants 2009
MCF-32B	UMCf	0.068	Slug	Hvorslev	Converse Consultants 2009
MCF-32B	UMCf	0.064	Slug	Bouwer Rice	Converse Consultants 2009
MCF-32B	UMCf	0.0818	Slug	Hvorslev	Converse Consultants 2009
MCF-32B	UMCf	0.0818	Slug	Bouwer Rice	Converse Consultants 2009
MCF-BW-10A	UMCf	2.5	Slug	Bouwer-Rice	Kleinfelder 2008
MCF-BW-10A	UMCf	2.82	Slug	Bouwer-Rice	Kleinfelder 2008
MCF-BW-10A	UMCf	2.85	Slug	Bouwer-Rice	Kleinfelder 2008
MCF-BW-10A	UMCf	2.9	Slug	Bouwer-Rice	Kleinfelder 2008
MCF-BW-11A	UMCf	1.01	Slug	Bouwer-Rice	Kleinfelder 2008
MCF-BW-11A	UMCf	1	Slug	Bouwer-Rice	Kleinfelder 2008
MCF-BW-11A	UMCf	1.1	Slug	Bouwer-Rice	Kleinfelder 2008
MCF-BW-11A	UMCf	1.05	Slug	Bouwer-Rice	Kleinfelder 2008
MC-MW-18	UMCf	0.4577	Slug	--	Ramboll Environ 2016

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
MC-MW-18	UMCf	0.4447	Slug	--	Ramboll Environ 2016
MC-MW-18	UMCf	0.4262	Slug	--	Ramboll Environ 2016
MC-MW-18	UMCf	0.4504	Slug	--	Ramboll Environ 2016
MC-MW-32	UMCf	0.055	Slug	Bouwer-Rice	AECOM 2011
MC-MW-32	UMCf	0.085	Slug	Hvorslev	AECOM 2011
MC-MW-32	UMCf	0.02	Slug	Bouwer-Rice	AECOM 2011
MC-MW-32	UMCf	0.029	Slug	Hvorslev	AECOM 2011
MC-MW-33	UMCf	0.011	Slug	Bouwer-Rice	AECOM 2011
MC-MW-33	UMCf	0.014	Slug	Hvorslev	AECOM 2011
MC-MW-33	UMCf	0.003	Slug	Bouwer-Rice	AECOM 2011
MC-MW-33	UMCf	0.004	Slug	Hvorslev	AECOM 2011
MC-MW-34	UMCf	0.069	Slug	Bouwer-Rice	AECOM 2011
MC-MW-34	UMCf	0.093	Slug	Hvorslev	AECOM 2011
MC-MW-34	UMCf	0.064	Slug	Bouwer-Rice	AECOM 2011
MC-MW-34	UMCf	0.086	Slug	Hvorslev	AECOM 2011
MC-MW-35	UMCf	1.036	Slug	Bouwer-Rice	AECOM 2011
MC-MW-35	UMCf	1.289	Slug	Hvorslev	AECOM 2011
MC-MW-35	UMCf	0.64	Slug	Bouwer-Rice	AECOM 2011
MC-MW-35	UMCf	0.851	Slug	Hvorslev	AECOM 2011
MC-MW-36	UMCf	0.067	Slug	Bouwer-Rice	AECOM 2011
MC-MW-36	UMCf	0.101	Slug	Hvorslev	AECOM 2011
MC-MW-36	UMCf	0.024	Slug	Bouwer-Rice	AECOM 2011
MC-MW-36	UMCf	0.032	Slug	Hvorslev	AECOM 2011
MC-MW-37	UMCf	6.923	Slug	Bouwer-Rice	AECOM 2011
MC-MW-37	UMCf	8.724	Slug	Hvorslev	AECOM 2011
MC-MW-37	UMCf	8.851	Slug	Bouwer-Rice	AECOM 2011
MC-MW-37	UMCf	9.908	Slug	Hvorslev	AECOM 2011
MC-MW-38	UMCf	0.115	Slug	Bouwer-Rice	AECOM 2011

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
MC-MW-38	UMCf	0.12	Slug	Hvorslev	AECOM 2011
MC-MW-38	UMCf	0.256	Slug	Bouwer-Rice	AECOM 2011
MC-MW-38	UMCf	0.356	Slug	Hvorslev	AECOM 2011
MC-MW-39	UMCf	0.2493	Slug	--	Ramboll Environ 2016
MC-MW-39	UMCf	0.2238	Slug	--	Ramboll Environ 2016
MC-MW-39	UMCf	0.2683	Slug	--	Ramboll Environ 2016
MC-MW-42	UMCf	0.01055	Slug	--	Ramboll Environ 2016
MC-MW-42	UMCf	0.01211	Slug	--	Ramboll Environ 2016
MC-MW-43	UMCf	0.11	Lab	--	AECOM 2014
MW-13	Qal	120	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
MW-14	Wash Gravels	59	Slug	Hvorslev	Converse Consultants 2006b
MW-14	Wash Gravels	59	Slug	Hvorslev	Converse Consultants 2006b
MW-14	Wash Gravels	46	Slug	Hvorslev	Converse Consultants 2006b
MW-14	Wash Gravels	107	Slug	Hvorslev	Converse Consultants 2006b
MW-14	Wash Gravels	143	Slug	Hvorslev	Converse Consultants 2006b
MW-14	Wash Gravels	111	Slug	Hvorslev	Converse Consultants 2006b
MW-14	Wash Gravels	32	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-14	Wash Gravels	44	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-14	Wash Gravels	80	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-14	Wash Gravels	62	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-14	Wash Gravels	100	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-14	Wash Gravels	72	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-2	Wash Gravels	108	Slug	Hvorslev	Converse Consultants 2002
MW-2	Wash Gravels	67	Slug	Hvorslev	Converse Consultants 2002
MW-2	Wash Gravels	57	Slug	Hvorslev	Converse Consultants 2002
MW-2	Wash Gravels	80	Slug	Hvorslev	Converse Consultants 2002
MW-2	Wash Gravels	80	Slug	Hvorslev	Converse Consultants 2002
MW-2	Wash Gravels	80	Slug	Hvorslev	Converse Consultants 2002

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
MW-2	Wash Gravels	70	Slug	Bouwer-Rice	Converse Consultants 2002
MW-2	Wash Gravels	33	Slug	Bouwer-Rice	Converse Consultants 2002
MW-2	Wash Gravels	29	Slug	Bouwer-Rice	Converse Consultants 2002
MW-2	Wash Gravels	59	Slug	Bouwer-Rice	Converse Consultants 2002
MW-2	Wash Gravels	35	Slug	Bouwer-Rice	Converse Consultants 2002
MW-2	Wash Gravels	73	Slug	Bouwer-Rice	Converse Consultants 2002
MW-6	Wash Gravels	59	Slug	Hvorslev	Converse Consultants 2002
MW-6	Wash Gravels	59	Slug	Hvorslev	Converse Consultants 2002
MW-6	Wash Gravels	87	Slug	Hvorslev	Converse Consultants 2002
MW-6	Wash Gravels	46	Slug	Hvorslev	Converse Consultants 2002
MW-6	Wash Gravels	54	Slug	Hvorslev	Converse Consultants 2002
MW-6	Wash Gravels	53	Slug	Hvorslev	Converse Consultants 2002
MW-6	Wash Gravels	42	Slug	Bouwer-Rice	Converse Consultants 2002
MW-6	Wash Gravels	56	Slug	Bouwer-Rice	Converse Consultants 2002
MW-6	Wash Gravels	66	Slug	Bouwer-Rice	Converse Consultants 2002
MW-6	Wash Gravels	33	Slug	Bouwer-Rice	Converse Consultants 2002
MW-6	Wash Gravels	38	Slug	Bouwer-Rice	Converse Consultants 2002
MW-6	Wash Gravels	39	Slug	Bouwer-Rice	Converse Consultants 2002
MW-9A	Wash Gravels	102	Slug	Hvorslev	Converse Consultants 2006b
MW-9A	Wash Gravels	80	Slug	Hvorslev	Converse Consultants 2006b
MW-9A	Wash Gravels	167	Slug	Hvorslev	Converse Consultants 2006b
MW-9A	Wash Gravels	130	Slug	Hvorslev	Converse Consultants 2006b
MW-9A	Wash Gravels	219	Slug	Hvorslev	Converse Consultants 2006b
MW-9A	Wash Gravels	192	Slug	Hvorslev	Converse Consultants 2006b
MW-9A	Wash Gravels	112	Slug	Hvorslev	Converse Consultants 2006b
MW-9A	Wash Gravels	159	Slug	Hvorslev	Converse Consultants 2006b
MW-9A	Wash Gravels	50	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-9A	Wash Gravels	126	Slug	Bouwer-Rice	Converse Consultants 2006b

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
MW-9A	Wash Gravels	98	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-9A	Wash Gravels	96	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-9A	Wash Gravels	145	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-9A	Wash Gravels	159	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-9A	Wash Gravels	130	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-9A	Wash Gravels	71	Slug	Bouwer-Rice	Converse Consultants 2006b
MW-AL	UMCf-cg	3.748	Slug	Bouwer-Rice	Geosyntec 2010
MW-AL	UMCf-cg	3.753	Slug	Bouwer-Rice	Geosyntec 2010
MW-C	UMCf-cg	3.627	Slug	Bouwer-Rice	Geosyntec 2010
MW-D2D	UMCf-cg	2.587	Slug	Bouwer-Rice	Geosyntec 2010
MW-D2D	UMCf-cg	2.722	Slug	Bouwer-Rice	Geosyntec 2010
MW-D2D	UMCf-cg	2.608	Slug	Bouwer-Rice	Geosyntec 2010
NERT4.93S1	Wash Gravels	120.0	Slug	Springer-Gelhar (1991)	Tetra Tech 2019b
OW-1	Wash Gravels	410.0	Not Available	Hantush-Jacob (leakage), AquiferTest Software	Converse Consultants 2002
OW-1	Wash Gravels	485.0	Not Available	Cooper-Jacob Time-Drawdown, AquiferTest Software	Converse Consultants 2002
OW-1	Wash Gravels	468.5	Not Available	Cooper-Jacob Time-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-1	Wash Gravels	452.3	Not Available	Cooper-Jacob Time-Dist-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-1	Wash Gravels	792.4	Not Available	Theis-Residual Drawdown, AquiferTest Software	Converse Consultants 2002
OW-1	Wash Gravels	1093.1	Not Available	Theis-Residual Drawdown, Graphical Calculation	Converse Consultants 2002
OW-1	Wash Gravels	936.9	Not Available	Theis-Theoretical Recovery, Graphical Calculation	Converse Consultants 2002
OW-2	Wash Gravels	545.0	Not Available	Cooper-Jacob Time-Drawdown, AquiferTest Software	Converse Consultants 2002
OW-2	Wash Gravels	515.0	Not Available	Cooper-Jacob Time-Dist-Drawdown, AquiferTest Software	Converse Consultants 2002

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
OW-2	Wash Gravels	210.5	Not Available	Neuman, AquiferTest Software	Converse Consultants 2002
OW-2	Wash Gravels	531.8	Not Available	Cooper-Jacob Time-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-2	Wash Gravels	511.0	Not Available	Cooper-Jacob Time-Dist-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-2	Wash Gravels	792.4	Not Available	Theis-Residual Drawdown, AquiferTest Software	Converse Consultants 2002
OW-2	Wash Gravels	1356.9	Not Available	Theis-Residual Drawdown, Graphical Calculation	Converse Consultants 2002
OW-2	Wash Gravels	570.3	Not Available	Theis-Theoretical Recovery, Graphical Calculation	Converse Consultants 2002
OW-3	Wash Gravels	517.5	Not Available	Cooper-Jacob Time-Drawdown, AquiferTest Software	Converse Consultants 2002
OW-3	Wash Gravels	475.0	Not Available	Cooper-Jacob Time-Dist-Drawdown, AquiferTest Software	Converse Consultants 2002
OW-3	Wash Gravels	504.5	Not Available	Cooper-Jacob Time-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-3	Wash Gravels	511.0	Not Available	Cooper-Jacob Time-Dist-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-3	Wash Gravels	1577.4	Not Available	Theis-Residual Drawdown, AquiferTest Software	Converse Consultants 2002
OW-3	Wash Gravels	1490.5	Not Available	Theis-Residual Drawdown, Graphical Calculation	Converse Consultants 2002
OW-3	Wash Gravels	1405.4	Not Available	Theis-Theoretical Recovery, Graphical Calculation	Converse Consultants 2002
P-1	Wash Gravels	1959.5	Pump	Jacob straight line	Converse Consultants 1986
P-2	Wash Gravels	1764.6	Pump	Jacob straight line	Converse Consultants 1986
P-3	Wash Gravels	1696.7	Pump	Jacob straight line	Converse Consultants 1986
PC-115R	Paleochannels	23	Pump	--	Ramboll Environ 2016
PC-116R	Paleochannels	535	Pump	--	Seep Aquifer Parameters 2007
PC-117	Paleochannels	6	Step	--	Hydraulic Conductivity SWF 2003
PC-117	Paleochannels	11	Step	--	Hydraulic Conductivity SWF 2003

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
PC-117	Paleochannels	14	Step	--	Hydraulic Conductivity SWF 2003
PC-117	Paleochannels	28	Step	--	Hydraulic Conductivity SWF 2003
PC-118	Paleochannels	6	Step	--	Hydraulic Conductivity SWF 2003
PC-118	Paleochannels	25	Step	--	Hydraulic Conductivity SWF 2003
PC-118	Paleochannels	37	Step	--	Hydraulic Conductivity SWF 2003
PC-118	Paleochannels	141	Step	--	Hydraulic Conductivity SWF 2003
PC-119	Paleochannels	6	Step	--	Hydraulic Conductivity SWF 2003
PC-119	Paleochannels	80	Step	--	Hydraulic Conductivity SWF 2003
PC-119	Paleochannels	94	Step	--	Hydraulic Conductivity SWF 2003
PC-119	Paleochannels	4560	Step	--	Hydraulic Conductivity SWF 2003
PC-120	Qal	6	Step	--	Hydraulic Conductivity SWF 2003
PC-120	Qal	33	Step	--	Hydraulic Conductivity SWF 2003
PC-120	Qal	37	Step	--	Hydraulic Conductivity SWF 2003
PC-120	Qal	904.8	Step	--	Hydraulic Conductivity SWF 2003
PC-133	Qal	14	Step	Jacobs semi-log straight line	PC-133 Pump Test Analyses 2004
PC-134A	UMCf	3.4	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-134A	UMCf	3.6	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-134A	UMCf	3.3	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-134A	UMCf	3.2	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-134A	UMCf	3.6	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-134A	UMCf	3.9	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-134A	UMCf	3.5	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-134A	UMCf	3.5	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-135	Paleochannels	2.46E-02	Lab	--	Crowley Environmental 2009
PC-137	UMCf	2.98E-03	Lab	--	Crowley Environmental 2009

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
PC-137	UMCf	3.9	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-137	UMCf	4.4	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-137	UMCf	4	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-137	UMCf	4	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-137	UMCf	4.3	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-137	UMCf	4.6	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-137	UMCf	4	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-137	UMCf	4.4	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-148	UMCf	0.1	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-148	UMCf	0.1	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-148	UMCf	0.1	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-148	UMCf	0.1	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-149	Qal/UMCf	0.8	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-149	Qal/UMCf	1.1	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-149	Qal/UMCf	0.8	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-149	Qal/UMCf	1.1	Slug	Bouwer-Rice	Ramboll Environ 2013
PC-149	Qal/UMCf	1.5	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-149	Qal/UMCf	1.1	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-149	Qal/UMCf	1.3	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-149	Qal/UMCf	1	Slug	Kansas Geological Survey (Hyder et al., 1994)	Ramboll Environ 2013
PC-150	Paleochannels	4.5	Step	Moench	Ramboll Environ 2013

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
PC-161	Paleochannels	54	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-161	Paleochannels	73	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-161	Paleochannels	62	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-161	Paleochannels	73	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-162	Qal/UMCf	31	Slug	Springer and Gelhar (1991)	[1]
PC-163	Qal/UMCf	0.88	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-163	Qal/UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-163	Qal/UMCf	1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-163	Qal/UMCf	1.1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-164	Paleochannels	5.1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-165	Qal	51	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-165	Qal	47	Slug	Springer and Gelhar (1991)	[1]
PC-165	Qal	66	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-165	Qal	42	Slug	Springer and Gelhar (1991)	[1]
PC-165	Qal	52	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-165	Qal	47	Slug	Springer and Gelhar (1991)	[1]
PC-166	Qal	28	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-166	Qal	43	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-166	Qal	31	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-166	Qal	36	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-167	Qal/UMCf	5.8	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-167	Qal/UMCf	6	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-167	Qal/UMCf	6.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-167	Qal/UMCf	3.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-169	Qal	32	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-169	Qal	110	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-169	Qal	63	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-169	Qal	72	Slug	Zlotnick, Goss and Dufield (2010)	[1]

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
PC-171	Paleochannels	10	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-171	Paleochannels	10	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-171	Paleochannels	11	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-171	Paleochannels	9.4	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-173	Paleochannels	45	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-173	Paleochannels	31	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-173	Paleochannels	73	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-173	Paleochannels	18	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-175	Qal	13	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-175	Qal	21	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-175	Qal	15	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-175	Qal	13	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-175	Qal	16	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-175	Qal	19	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-177	UMCf	0.038	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-178	UMCf	0.14	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-178	UMCf	0.14	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-179	UMCf	0.026	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-180	UMCf	0.25	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-180	UMCf	0.16	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-181	UMCf	0.51	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-181	UMCf	0.47	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-182	UMCf	0.065	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-183	UMCf	0.98	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-183	UMCf	0.6	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-183	UMCf	1.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-183	UMCf	0.64	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-184	UMCf	0.033	Slug	Zlotnick, Goss and Dufield (2010)	[1]

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
PC-185	UMCf	0.53	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-185	UMCf	0.5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-186	Paleochannels	43	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-186	Paleochannels	42	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-186	Paleochannels	43	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-186	Paleochannels	47	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-186	Paleochannels	44	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-186	Paleochannels	48	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-187	UMCf	0.25	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-188	UMCf	0.91	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-188	UMCf	0.78	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-189	UMCf	0.065	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-19	Paleochannels	7.62	Step	--	Batista, J.R., et al. 2003
PC-190	Paleochannels	79	Slug	Springer and Gelhar (1991)	[1]
PC-190	Paleochannels	87	Slug	Springer and Gelhar (1991)	[1]
PC-190	Paleochannels	97	Slug	Springer and Gelhar (1991)	[1]
PC-190	Paleochannels	92	Slug	Springer and Gelhar (1991)	[1]
PC-191	Qal	130	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-191	Qal	88	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-191	Qal	120	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-191	Qal	70	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-192	UMCf	0.67	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-192	UMCf	0.37	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-192	UMCf	0.43	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-192	UMCf	0.26	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-193	UMCf	2.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-193	UMCf	1.8	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-193	UMCf	2.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
PC-193	UMCf	2.7	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-193	UMCf	2.4	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-193	UMCf	2.2	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-193	UMCf	2.5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-193	UMCf	2.4	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-194	UMCf	0.1	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-195	UMCf	1.5	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-195	UMCf	1.8	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-196	UMCf	0.29	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-197	UMCf	0.077	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-197	UMCf	0.086	Slug	Zlotnick, Goss and Dufield (2010)	[1]
PC-54	Paleochannels	117.79	Pump	Cooper & Jacob, recovery	TIMET 2007
PC-55	Paleochannels	5.08	Pump	--	Batista, J.R., et al. 2003
PC-55	Paleochannels	5.88	Step	--	Batista, J.R., et al. 2003
PC-55	Paleochannels	6.15	Pump	--	Batista, J.R., et al. 2003
PC-65	Qal	19.46	Pump	Cooper & Jacob, recovery	TIMET 2007
PC-67	Qal	21.73	Pump	Cooper & Jacob, recovery	TIMET 2007
PC-70	Paleochannels	207	Pump	Jacobs, drawdown	KMCC 1998
PC-70	Paleochannels	292	Pump	Jacobs, recovery	KMCC 1998
PC-70	Paleochannels	201	Pump	Jacobs, drawdown	KMCC 1998
PC-70	Paleochannels	227	Pump	Theis, drawdown	KMCC 1998
PC-70	Paleochannels	190	Pump	Boulton, drawdown	KMCC 1998
PC-70	Paleochannels	321	Pump	Jacobs, recovery	KMCC 1998
PC-70	Paleochannels	166	Pump	Jacobs, drawdown	KMCC 1998
PC-70	Paleochannels	220	Pump	Theis, drawdown	KMCC 1998
PC-70	Paleochannels	218	Pump	Boulton, drawdown	KMCC 1998
PC-70	Paleochannels	438	Pump	Jacobs, recovery	KMCC 1998
PC-70	Paleochannels	239	Pump	Jacobs, drawdown	KMCC 1998

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
PC-70	Paleochannels	169	Pump	Theis, drawdown	KMCC 1998
PC-70	Paleochannels	143	Pump	Boulton, drawdown	KMCC 1998
PC-70	Paleochannels	477	Pump	Jacobs, recovery	KMCC 1998
PC-70	Paleochannels	203	Pump	Distance-drawdown @ 100 min, Jacobs semi-log straight-line	KMCC 1998
PC-70	Paleochannels	195	Pump	Distance-drawdown @ 720 min, Jacobs semi-log straight-line	KMCC 1998
PC-70	Paleochannels	191	Pump	Distance-drawdown @ 1440 min, Jacobs semi-log straight-line	KMCC 1998
PC-70	Paleochannels	203	Pump	Distance-drawdown @ 2160 min, Jacobs semi-log straight-line	KMCC 1998
PC-70	Paleochannels	203	Pump	Distance-drawdown @ 2880 min, Jacobs semi-log straight-line	KMCC 1998
PC-70	Paleochannels	207	Step	--	Hydraulic Conductivity ART 2001
PC-70	Paleochannels	227.8	Tracer	Cooper Jacob drawdown, Theis recovery	Montgomery 2000
PC-94	Qal	3	Slug	Bouwer-Rice	Tetra Tech 2016
PC-94	Qal	2.5	Slug	Bouwer-Rice	Tetra Tech 2016
PC-98R	Paleochannels	294.8	Tracer	Cooper Jacob drawdown, Theis recovery	Montgomery 2000
PC-99R	Paleochannels	616.4	Tracer	Cooper Jacob drawdown, Theis recovery	Montgomery 2000
PC-99R3	Qal	--	--	--	Seep Aquifer Parameters 2007
POD6-R	Qal	687.82	Not Available	Theis recovery	Tetra Tech 1998
POD6-R	Qal	866.73	Not Available	Theis recovery	Tetra Tech 1998
POD8	Qal	2.0899	Not Available	Neuman	Tetra Tech 1998
POD8	Qal	3.1826	Not Available	Theis recovery	Tetra Tech 1998
POU1	Paleochannels	0.017	Not Available	Bouwer-Rice	Tetra Tech 1998
POU1	Paleochannels	0.0561	Slug	Cooper-Papodopolous	Tetra Tech 1998
SWFTS-IW01A	Qal	6.8	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW01A	Qal	0.58	Slug	Bouwer-Rice	Tetra Tech 2016

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
SWFTS-IW01A	Qal	0.26	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW01B	Qal	48	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW02A	Qal	25	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW02B	Qal	33	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW03	Qal	43	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW04	Qal	46	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW05	Qal	81	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-IW05	Qal	0.036	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW05	Qal	0.13	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW06A	Qal	35	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW06A	Qal	0.21	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW06A	Qal	0.17	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW06B	Qal	93	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW07	Qal	29	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW08	Qal	5.2	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW08	Qal	0.057	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW08	Qal	0.048	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW09	Qal	19	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW09	Qal	0.74	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW09	Qal	0.11	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW10	Qal	30	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW11	Qal	21	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW11	Qal	0.015	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW11	Qal	0.85	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW12	Qal	16	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW13A	Qal	9.5	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW13A	Qal	1.2	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW13A	Qal	0.074	Slug	Bouwer-Rice	Tetra Tech 2016

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
SWFTS-IW13B	Qal	60	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW13B	Qal	0.12	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW13B	Qal	0.11	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW14	Qal	37	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW15	Qal	140	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-IW15	Qal	0.058	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW15	Qal	0.051	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW16A	Qal	24	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW16B	Qal	86	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW17	Qal	69	Slug	Bouwer-Rice, Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-IW17	Qal	0.15	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW17	Qal	0.0075	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW18	Qal	28	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW18	Qal	0.18	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW19	Qal	150	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-IW19	Qal	0.15	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW19	Qal	0.3	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW20	Qal	38	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW20	Qal	0.027	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-IW20	Qal	0.006	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW01	Qal	48	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW02	Qal	8.4	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW03	Qal	190	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW03	Qal	240	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW03	Qal	150	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW04	Qal	18	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW05A	Qal	6.8	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW05B	Qal	49	Slug	Bouwer-Rice	Tetra Tech 2016

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
SWFTS-MW05B	Qal	49	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW05B	Qal	66	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW06A	Qal	5.8	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW06B	Qal	25	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW07A	Qal	2.8	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW07B	Qal	28	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW08A	Qal	1.3	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW08C	UMCf	2.4	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW09A	Qal	37	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW09A	Qal	37	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW09A	Qal	42	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW09B	Qal	330	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW09B	Qal	290	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW09B	Qal	300	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW10A	Qal	17	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW10A	Qal	21	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW10A	Qal	17	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW10C	UMCf	2.4	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW11	Qal	0.74	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW12	Qal	7.3	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW13	Qal	0.76	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW14	Qal	97	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW14	Qal	82	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW14	Qal	13	Slug	Bouwer-Rice, Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW15	Qal	43	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW16	Qal	51	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW16	Qal	50	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW16	Qal	13	Slug	Bouwer-Rice, Springer-Gelhar (1991)	Tetra Tech 2016

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
SWFTS-MW17	Qal	4.2	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW18	Qal	25	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW19	Qal	1.4	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW20	Qal	58	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW21	Qal	3.8	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW21	Qal	4.1	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW21	Qal	30	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW22	Qal	85	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW23	Qal	34	Slug	Bouwer-Rice	Tetra Tech 2016
SWFTS-MW24	Qal	120	Slug	Bouwer-Rice, Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW25	Qal	82	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW25	Qal	86	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
SWFTS-MW25	Qal	59	Slug	Springer-Gelhar (1991)	Tetra Tech 2016
TMMW-101	Qal/UMCf	2.30	Pump	Cooper & Jacob, recovery	TIMET 2007
TMMW-102	xMCf	0.07	Slug	Bouwer and Rice, 1976	TIMET 2007
TMMW-103	Qal/UMCf	1.43	Pump	Cooper & Jacob, recovery	TIMET 2007
TMMW-104	Qal/UMCf	1.25	Pump	Cooper & Jacob, recovery	TIMET 2007
TMPZ-105	Qal	10.7	Pump	--	TIMET 2008
TMPZ-106	Qal	41.2	Pump	--	TIMET 2008
TMPZ-107	Qal	89.9	Pump	--	TIMET 2008
TMPZ-108	Qal	14.7	Pump	--	TIMET 2008
TMPZ-109	Qal	66	Pump	--	TIMET 2008
TMPZ-110	Qal	5.40	Pump	Cooper & Jacob, recovery	TIMET 2007
TMPZ-111 / EWQal-11	Qal	8.7	Pump	--	TIMET 2008
TMPZ-112 / EWQal-22	xMCf	3.2	Pump	--	TIMET 2008
TMPZ-201 / EWxMCF-06	xMCf	0.083	Pump	Cooper & Jacob, recovery	TIMET 2009
TMPZ-201 / EWxMCF-06	xMCf	2.5	Step	Hantush-Jacob CMT-102 obs well	TIMET 2009
TMPZ-202 / EWxMCF-08	xMCf	0.146	Pump	Cooper & Jacob, recovery	TIMET 2009

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
TMPZ-203 / EWxMCF-12	xMCf	0.243	Pump	Cooper & Jacob, recovery	TIMET 2009
TMPZ-204 / EWxMCF-17	xMCf	0.382	Pump	Cooper & Jacob, recovery	TIMET 2009
TMPZ-204 / EWxMCF-17	xMCf	16.85	Step	Hantush- TMPZ-603 obs well	TIMET 2009
TMPZ-204 / EWxMCF-17	xMCf	2.66	Step	Theis- TMPZ-604 obs well	TIMET 2009
TMPZ-204 / EWxMCF-17	xMCf	1.52	Step	Theis- TMPZ-605 obs well	TIMET 2009
TR-2	UMCf	3.92E-03	Slug	--	Ramboll Environ 2016
TR-2	UMCf	4.16E-03	Slug	--	Ramboll Environ 2016
TR-4	UMCf	3.07E-03	Slug	--	Ramboll Environ 2016
TR-4	UMCf	2.97E-03	Slug	--	Ramboll Environ 2016
TR-7	UMCf-cg	1.15	Slug	--	Ramboll Environ 2016
TR-7	UMCf-cg	1.154	Slug	--	Ramboll Environ 2016
TR-7	UMCf-cg	1.1499	Slug	--	Ramboll Environ 2016
TR-7	UMCf-cg	1.161	Slug	--	Ramboll Environ 2016
TR-9	UMCf-cg	2.734	Slug	--	Ramboll Environ 2016
TR-9	UMCf-cg	2.77	Slug	--	Ramboll Environ 2016
TR-9	UMCf-cg	3.022	Slug	--	Ramboll Environ 2016
TR-9	UMCf-cg	2.941	Slug	--	Ramboll Environ 2016
TWA-180	UMCf	0.02658	Slug	Bouwer-Rice	Geosyntec 2010
TWE-15	xMCf	74.66	Slug	Bouwer-Rice	Geosyntec 2010
TWE-15	xMCf	102	Slug	Bouwer-Rice	Geosyntec 2010
TWE-15	xMCf	40.36	Slug	Bouwer-Rice	Geosyntec 2010
TWE-15	xMCf	23.63	Slug	Bouwer-Rice	Geosyntec 2010
TWE-18	xMCf	5.972	Slug	Bouwer-Rice	Geosyntec 2010
TWE-18	xMCf	6.181	Slug	Bouwer-Rice	Geosyntec 2010
TWE-33	UMCf	0.4072	Slug	Bouwer-Rice	Geosyntec 2010
TWE-51	UMCf	0.1555	Slug	Bouwer-Rice	Geosyntec 2010
U4-E-01D	UMCf	0.055	Slug	Bouwer-Rice	Tetra Tech 2018c

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
U4-E-01D	UMCf	0.58	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-E-01I	UMCf	1.4	Slug	Bouwer-Rice	Tetra Tech 2018c
U4-E-01I	UMCf	10	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-E-01I	UMCf	0.84	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-E-02D	UMCf	0.062	Slug	Bouwer-Rice	Tetra Tech 2018c
U4-E-02D	UMCf	0.054	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-E-02I	UMCf	1.3	Slug	Bouwer-Rice	Tetra Tech 2018c
U4-E-02I	UMCf	6.7	Pump	Hantush-Jacob (1955)/Hantush (1964), Cooper-Jacob (1946)	Tetra Tech 2018c
U4-E-02I	UMCf	1.5	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-E-04D	UMCf	0.53	Slug	Bouwer-Rice	Tetra Tech 2018c
U4-E-04D	UMCf	2.4	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-E-04D	UMCf	1.6	Pump	Cooper-Jacob (1946), Confined	Tetra Tech 2018c
U4-E-04I	UMCf	1.8	Slug	Bouwer-Rice	Tetra Tech 2018c
U4-E-04I	UMCf	5.6	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-E-04I	UMCf	2.7	Pump	Cooper-Jacob (1946), Confined	Tetra Tech 2018c
U4-E-05D	UMCf	0.38	Slug	Bouwer-Rice	Tetra Tech 2018c
U4-E-05D	UMCf	1.4	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-E-05D	UMCf	0.39	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-E-05I	UMCf	1.5	Slug	Bouwer-Rice	Tetra Tech 2018c
U4-E-05I	UMCf	6.6	Pump	Cooper-Jacob (1946), Confined	Tetra Tech 2018c
U4-MW-02D	UMCf	0.13	Slug	Bouwer-Rice	Tetra Tech 2018c

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
U4-MW-02D	UMCf	1.4	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-MW-02D	UMCf	0.13	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
U4-MW-02I	UMCf	1.2	Slug	Bouwer-Rice	Tetra Tech 2018c
U4-MW-02I	UMCf	4.4	Pump	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018c
UFIW-01D	UMCf	1.9	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-01I	UMCf	9.7	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-01I	UMCf	0.33	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-01I	UMCf	1.4	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-02D	UMCf	1.4	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-02I	UMCf	0.96	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-03D	UMCf	7.3	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-03I	UMCf	11	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-04D	UMCf	4.6	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-04I	UMCf	13	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-04I	UMCf	1.3	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-04I	UMCf	1.9	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-05D	UMCf	0.5	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-05I	UMCf	4.9	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-05I	UMCf	2.2	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-05I	UMCf	0.88	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-06D	UMCf	0.94	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-06I	UMCf	2.5	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-06I	UMCf	1	Specific Capacity	Hantush-Jacob (1955)/Hantush (1964), Leaky	Tetra Tech 2018a
UFIW-06I	UMCf	0.57	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018a
UFIW-06S	Qal	11	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018a

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
UFIW-06S	Qal	4.5	Specific Capacity	Theis (1935), Unconfined	Tetra Tech 2018a
UFIW-07D	UMCf	2.1	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-07I	UMCf	3.7	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-08D	UMCf	1.2	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-08I	UMCf	2.7	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-08I	UMCf	0.44	Slug	Bouwer-Rice	Tetra Tech 2018a
UFIW-08I	UMCf	0.34	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-01D	UMCf	1.8	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-01D	UMCf	3	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-01I	UMCf	1.3	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-01I	UMCf	1.9	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-01I	UMCf	1.9	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-02D	UMCf	1.1	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-02D	UMCf	1.4	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-02I	UMCf	1	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-02I	UMCf	1.1	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-03D	UMCf	1.5	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-03D	UMCf	1.8	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-03I	UMCf	1.8	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-03I	UMCf	1.6	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-03I	UMCf	1.8	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-04D	UMCf	4.6	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-04D	UMCf	5.4	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-04I	UMCf	2.6	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-04I	UMCf	3.4	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-04I	UMCf	4.8	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-05D	UMCf	4.3	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-05D	UMCf	5.1	Slug	Bouwer-Rice	Tetra Tech 2018a

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
UFMW-05I	UMCf	1.1	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-05I	UMCf	1.9	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-05S	Qal	17	Specific Capacity	Cooper-Jacob (1946), Unconfined	Tetra Tech 2018a
UFMW-06D	UMCf	1.2	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-06D	UMCf	0.96	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-06I	UMCf	3.2	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-06I	UMCf	3.1	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-06I	UMCf	4.8	Slug	Bouwer-Rice	Tetra Tech 2018a
UFMW-06S	Qal	16	Specific Capacity	Cooper-Jacob (1946), Unconfined	Tetra Tech 2018a
ART-1	Qal	39.97	--	--	McGinley 2007
ART-1	Qal	40	--	Avg of Jacobs Semi-log and software program (KMG)	Hydraulic Conductivity ART 2007
ART-2	Qal	277.66	--	--	McGinley 2007
ART-2	Qal	278	--	Avg of Jacobs Semi-log and software program (KMG)	Hydraulic Conductivity ART 2007
ART-3	Qal	53.20	--	--	McGinley 2007
ART-3	Qal	53	--	Avg of Jacobs Semi-log and software program (KMG)	Hydraulic Conductivity ART 2007
ART-4	Qal	74.99	--	--	McGinley 2007
ART-4	Qal	75	--	Avg of Jacobs Semi-log and software program (KMG)	Hydraulic Conductivity ART 2007
ART-6	Qal	149.99	--	--	McGinley 2007
ART-6	Qal	150	--	Avg of Jacobs Semi-log and software program (KMG)	Hydraulic Conductivity ART 2007
ART-7	Qal	324.98	--	--	McGinley 2007
ART-7	Qal	325	--	Avg of Jacobs Semi-log and software program (KMG)	Hydraulic Conductivity ART 2007
ART-8	Qal	163.76	--	--	McGinley 2007
ART-8	Qal	164	--	Avg of Jacobs Semi-log and software program (KMG)	Hydraulic Conductivity ART 2007

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
ART-9	Qal	140.10	--	--	McGinley 2007
ART-9	Qal	140	--	Avg of Jacobs Semi-log and software program (KMG)	Hydraulic Conductivity ART 2007
B-1	--	0.45	Flexible Wall Test, ASTM D5084	--	Converse Consultants 1999
B17	--	6.4	Slug in 1	Bouwer-Rice	Kleinfelder 2008
B17	--	9.5	Slug out 1	Bouwer-Rice	Kleinfelder 2008
B17	--	6.1	Slug in 2	Bouwer-Rice	Kleinfelder 2008
B17	--	8.7	Slug out 2	Bouwer-Rice	Kleinfelder 2008
B17	--	6.25	Slug in 3	Bouwer-Rice	Kleinfelder 2008
B17	--	9.5	Slug out 3	Bouwer-Rice	Kleinfelder 2008
B18	--	2.02	Slug in 1	Bouwer-Rice	Kleinfelder 2008
B18	--	2	Slug out 1	Bouwer-Rice	Kleinfelder 2008
B18	--	2.2	Slug in 2	Bouwer-Rice	Kleinfelder 2008
B18	--	2.42	Slug out 2	Bouwer-Rice	Kleinfelder 2008
B18	--	2	Slug in 3	Bouwer-Rice	Kleinfelder 2008
B18	--	2.45	Slug out 3	Bouwer-Rice	Kleinfelder 2008
IW-1*	UMCf-cg	4.76E-02	--	--	GES 2003
IW-1*	UMCf-cg	4.76E-02	--	--	GES 2003
IW-1*	UMCf-cg	4.76E-02	--	--	GES 2003
IW-2*	--	6.63E-02	--	--	GES 2003
IW-2*	--	6.63E-02	--	--	GES 2003
IW-2*	--	6.63E-02	--	--	GES 2003
IW-3*	--	5.53E-02	--	--	GES 2003
IW-3*	--	5.53E-02	--	--	GES 2003
IW-3*	--	5.53E-02	--	--	GES 2003
IW-3*	--	5.53E-02	--	--	GES 2003
IW-3*	--	5.53E-02	--	--	GES 2003

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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]
M-11	Qal/xMCf/UMCf	1.14	Jacob semi-log	--	Batista, J.R., et al. 2003
M-11	Qal/xMCf/UMCf	0.87	Slug	--	Batista, J.R., et al. 2003
M-12	UMCf	2.57	Slug	--	Batista, J.R., et al. 2003
M-13	UMCf	4.83	Slug	--	Batista, J.R., et al. 2003
M-15	UMCf	40.91	Slug	--	Batista, J.R., et al. 2003
M-17	UMCf	24.33	Slug	--	Batista, J.R., et al. 2003
M-2	Qal	41.84	Slug	--	Batista, J.R., et al. 2003
M-2	Qal	60.56	Jacob semi-log	--	Batista, J.R., et al. 2003
M-27	Qal	199.99	Slug	--	Batista, J.R., et al. 2003
M-3	Qal	131.41	Slug	--	Batista, J.R., et al. 2003
M-4	Qal	6.71	Slug	--	Batista, J.R., et al. 2003
M-8	Qal/xMCf/UMCf	111.49	Slug	--	Batista, J.R., et al. 2003
M-9	Qal	7.29	Slug	--	Batista, J.R., et al. 2003
MC-MW-39	UMCf	0.2	Rising Head	--	Ramboll Environ 2016
Seep Area	--	457	--	--	McGinley 2003

Notes:

Qal= Quaternary Alluvium

UMCf = Upper Muddy Creek Formation

xMCf = Transitional Muddy Creek Formation

ft/d = feet per day

-- = no data available

[1] Litholologic unit classification for wells was taken from the NDEP All Wells Database or technical report description. Some minor modifications were made as described in Section 1.1.2 of Appendix D.

[2] References for hydraulic properties measured within the Study Area

Data in shaded rows were excluded from statistical summary because they were determined to likely be duplicative of other data, they could not be assigned to a lithologic unit, or they were associated with non-standard site conditions (i.e., a demonstration weir).

Sources:

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
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Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]

AECOM. 2011. Revised Upper Muddy Creek Formation Additional Investigation Report, OSSM Joint Groundwater Program, Hederson, Nevada. November 23.

AECOM. 2014. Revised DNAPL Investigation Summary Report Montrose Chemical Corporation of California Environmental Conditions Investigation, Henderson, Nevada. May 15. Prepared for Montrose Chemical Corporation of California.

American Pacific Corporation (AMPAC). 2011a. Semi-Annual Performance (January 1-June 30, 2010) and 2010 Annual Groundwater Monitoring Report. January 12.

AMPAC. 2011b. Remediation System Work Plan for the AMPAC Groundwater Treatment System (AGTS) at Henderson, Nevada. June 2.

Batista, J.R., et al. 2003. The Fate and Transport of Perchlorate in a Contaminated Site in the Las Vegas Valley. March. Prepared for USEPA.

Converse Consultants. 1986. Geotechnical Site Investigation Las Vegas Wash Crossing of the Lass Vegas Valley Lateral Pipeline, Las Vegas, Nevada. June 4. Prepared for Boyle Engineering Corporation.

Converse Consultants. 1999. Preliminary Geotechnical and Geologic Investigation: Industrial Non-Hazardous Disposal Facility, Basic Management Incorporated, Clark County, Nevada. October 27. Prepared for Parsons Engineering Science, Inc.

Converse Consultants. 2002. Geotechnical Data Report: Southern Nevada Water Authority Contract No. 170A, Rainbow Gardens Weir W-3.5 Las Vegas Wash, 1/2 Mile Upstream of Lake Las Vegas, Clark County, Nevada. June 27. Prepared for Boyle Engineering Corporation.

Converse Consultants. 2006a. Geotechnical Data Report: Southern Nevada Water Authority Contract No. 810X, Upper Narrows Weir 7,500 Feet East of Broadbent Boulevard at the Las Vegas Wash, Clark County, Nevada. February 21.

Converse Consultants. 2006b. Geotechnical Data Report: Southern Nevada Water Authority Contract No. 810G, Duck Creek Confluence Weir 1 Mile East of Sam Boyd Stadium at the Las Vegas Wash, Clark County, Nevada. February 22.

Converse Consultants. 2009. Limited Hydrogeologic Investigation: BMI Common Areas (Eastside), Henderson, Nevada. Prepared for Basic Remediation Company. November 25.

Crowley Environmental. 2009. Interim Groundwater Capture Evaluation and Vertical Delineation Report, Tronox LLC, Henderson, Nevada. December 23. Prepared for Tronox LLC.

Errol L. Montgomery & Associates, Inc (Montogomery). 2000. Analysis of Rate of Groundwater Movement Based on Results of Tracer and Hydraulic Tests Conducted Between Pittman Lateral and Seep Area, Henderson, Nevada. December 19. Prepared for Kerr-McGee Chemical, LLC.

Geosyntec Consultants (Geosyntec). 2010. Groundwater Flow Model: South of Warm Springs Study Area Henderson, Nevada. March 31. Prepared for American Pacific Corporation.

Geosyntec. 2014. Revised Conceptual Site Model for the Closed Ponds Area and Former Tank Farm Site Assessment Areas, Henderson, Nevada. January 17. Prepared for Montrose Chemical Corporation of California.

Geotechnical & Environmental Services, Inc. (GES) 2003. Geotechnical Investigation: Demonstration Weir W-3.9 Replacement SNWA Contract No. 810-K, Las Vegas Wash Erosion Control Program, Clark County, Nevada. August 8.

GES. 2005a. Geotehcnical Investigation: Homestead Weir W-8.5 SNWA Contract No. 810L, Las Vegas Wash Erosion Control Program, Clark County, Nevada. December 7.

GES. 2005b. Geotehcnical Investigation: Lower Narrows Weir W-8.5 SNWA Contract No. 810M, Las Vegas Wash Erosion Control Program, Clark County, Nevada. December 7.

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]

GES. 2007a. Geotechnical Investigation: Sunrise Mountain Outfall Weir SNWA Contract No. 810W, Las Vegas Wash Erosion Control Program, Clark County, Nevada. February 23.

GES. 2007b. Geotechnical Investigation: Relocated Homestead Weir SNWA Contract No. 810M, Las Vegas Wash Erosion Control Program, Clark County, Nevada. November 1.

GES. 2007c. Geotechnical Investigation: Relocated Lower Narrows Weir SNWA Contract No. 810M, Las Vegas Wash Erosion Control Program, Clark County, Nevada. November 1.

Geraghty & Miller, Inc. 1980. Ground-Water Investigation Stauffer Chemical Company, Henderson, Nevada. October.

Hydraulic Conductivity Measurements From Step Discharge Tests in ART Wells, Athens Road Well Field (Nov 2001). Excel file.

Hydraulic Conductivity Measurements from Step Discharge Tests in New Seep Wells, Feb. 2003. Excel File.

K values from ART well pump tests. 2007. Correspondence between Ed Krish of Frontier Net and Brian Giroux of McGinley.

Kerr-McGee Chemical Corporation (KMCC). 1985. Geohydrological Investigation Kerr-McGee Chemical Corporation Hendreson Facility. July. Prepared By Hydrology Services Group Assessment and Remediation Department Kerr-McGee Safety and Environmental Affairs Division.

KMCC. 1998. Preliminary Report on a Hydrogeologic Investigation of Channel-fill Alluvium at the Pittman Lateral, Henderson, Nevada. Prepared By Hydrology Services Group Assessment and Remediation Department Kerr-McGee Safety and Environmental Affairs Division.

Kleinfelder. 2007a. Implementation of the Work Plan for Shallow Well Installation and Associated Soil Sampling, BMI Common Area Eastside, Henderson, Nevada. October 8. Prepared for Basic Remediation Company.

Kleinfelder. 2007b. Implementation of the Revised Aquifer Testing Work Plan: BMI Common Area Eastside, Henderson, Nevada. November 16.

Kleinfelder. 2008. Slug Test Results CAMU Area, Henderson, Nevada. Letter to Basic Remediation Company. January 25.

McGinley & Associates (McGinley). 2003. Las Vegas Wash Initial Perchlorate Modeling Report. October 20. Prepared for Nevada Division of Environmental Protection.

McGinley. 2007. Athens Road Well Field Modeling Report: Near BMI Industrial Complex, Henderson, Nevada. June 30. Prepared for Nevada Division of Environmental Protection.

Ninyo & Moore. 2004. Geotechnical Evaluation: SNWA Contract No. 810-R, Landfill Weir (W-5.1), Clark County, Nevada. March 19.

PC-133 Pump Test Analyses, Test Date: December 10-11, 2004. Excel file.

Ramboll Environ. 2013 GWETS Optimization Project Report. Excel file.

Ramboll Environ. 2016. Historical Aquifer Testing Data Compilation. Continuous Optimization Program Hydrogeologic Investigation.

Seep Aquifer Parameters 2007. Info from Tom 8/2/07. Word file.

Stauffer Chemical Company (Stauffer). 1983. 1982 Hydrogeologic Investigation in Support of the Ground-Water Intercept System at Stauffer Chemical Company Henderson, Nevada. March.

Tetra Tech EM Inc. 1998. Draft Environmental Conditions Investigation Report, Titanium Metals Corporation Facility Environmental Conditions Investigation, Henderson, Nevada, Volume 1 of 3. February 20. Submitted to Nevada Division of Environmental Protection.

TABLE D-1. SUMMARY OF ESTIMATED HORIZONTAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Horizontal Hydraulic Conductivity (ft/d)	Test Type	Analysis	Report Source[2]

Tetra Tech. 2016. Final Seep Well Field Area Bioremediation Treatability Study Work Plan, Nevada Environmental Response Trust Site, Henderson, Nevada. September 6.

Tetra Tech. 2018a. AP Area Down and Up Flushing Treatability Study Results Report, Nevada Environmental Response Trust Site, Henderson, Nevada. Appendix E Aquifer Testing Results Technical Memorandum. December 21.

Tetra Tech. 2018b. In-Situ Chromium Treatability Study Results Report, Nevada Environmental Response Trust Site, Henderson, Nevada. March 22.

Tetra Tech. 2018c. Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan, Revision 1, Nevada Environmental Response Trust Site, Henderson, Nevada. February 5.

Tetra Tech. 2019a. Galleria Drive Bioremediation Treatability Study Work Plan Addendum, Nevada Environmental Response Trust Site, Henderson, Nevada. March 29.

Tetra Tech. 2019b. Las Vegas Wash Bioremediation Pilot Study Work Plan Addendum, Nevada Environmental Response Trust Site, Henderson, Nevada. February 15.

Tetra Tech. 2019c. Unit 4 and 5 Buildings Investigation Source Area Characterization Report. April.

Titanium Metals Corporation (TIMET). 2007. Conceptual Site Model Titanium Metals Corporation Facility Henderson, Nevada. April 25. Submitted to NDEP.

TIMET. 2008. Tasks I, II, and III, Data Transmittal Report in support of the Groundwater Remedial Alternatives Study. May 16.

TIMET Well Field Pumping Test Results. 2009. Excel file.

Tronox. 2010. Appendix C, Capture Zone Evaluation Report, Henderson, Nevada. December 3.

Wittman G.P. and Carter G.A. 2007. Kleinfelder Letter to Ranajit Sahu Basic Remediation Company. Subject: Slug Test Results BMI Common Area Henderson, Nevada. November 29.

[1] Preliminary results of aquifer testing conducted as part of the NERT Remedial Investigation (RI) Phase 2.

[2] Preliminary results of aquifer testing conducted as part of the NERT RI Phase 3.

TABLE D-2. SUMMARY OF ESTIMATED VERTICAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Vertical Hydraulic Conductivity (ft/d)	Test Method / Analysis	Report Source[2]
H-34	UMCf	3.4E-04	Laboratory Vertical Permeability Tests	Geraghty & Miller, Inc. 1980
H-34	UMCf	2.8E-04	Laboratory Vertical Permeability Tests	Geraghty & Miller, Inc. 1980
H-35	UMCf	0.0057	Laboratory Vertical Permeability Tests	Geraghty & Miller, Inc. 1980
H-36	Qal	3.4E-04	Laboratory Vertical Permeability Tests	Geraghty & Miller, Inc. 1980
H-36	Qal	1.6E-04	Laboratory Vertical Permeability Tests	Geraghty & Miller, Inc. 1980
M-129	Qal/UMCf	0.0030	ASTM D5084	Northgate 2009
M-129	Qal/UMCf	0.0030	ASTM D5084	Northgate 2010
M-130	UMCf	0.0027	ASTM D5085	Northgate 2009
M-130	UMCf	0.0027	ASTM D5084	Northgate 2010
M-132	UMCf	0.0081	ASTM D5086	Northgate 2009
M-132	UMCf	0.0081	ASTM D5084	Northgate 2010
M-136	UMCf	0.0082	ASTM D5087	Northgate 2009
M-136	UMCf	0.0082	ASTM D5084	Northgate 2010
M-161D	UMCf	0.011	API RP40, Mod. ASTM D425, EPA 9100	[1]
M-162	UMCf	8.9E-07	ASTM D5084	Northgate 2010
M-162	UMCf	4.3E-07	ASTM D5084	Northgate 2010
M-162	UMCf	5.1E-07	ASTM D5084	Northgate 2010
M-187	UMCf	4.1E-05	ASTM D5084	Northgate 2010
M-187	UMCf	3.6E-06	ASTM D5084	Northgate 2010
M-189	UMCf	0.010	API RP40, Mod. ASTM D425, EPA 9100	[1]
M-190	UMCf	0.0099	API RP40, Mod. ASTM D425, EPA 9100	[1]
M-190	UMCf	0.0074	API RP40, Mod. ASTM D425, EPA 9100	[1]
M-191	UMCf	0.010	API RP40, Mod. ASTM D425, EPA 9100	[1]
M-191	UMCf	0.0088	API RP40, Mod. ASTM D425, EPA 9100	[1]
M-192	UMCf	0.0074	API RP40, Mod. ASTM D425, EPA 9100	[1]
M-192	UMCf	0.040	API RP40, Mod. ASTM D425, EPA 9100	[1]
PC-135	Paleochannels	0.025	ASTM D5088	Northgate 2009

TABLE D-2. SUMMARY OF ESTIMATED VERTICAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Vertical Hydraulic Conductivity (ft/d)	Test Method / Analysis	Report Source[2]
PC-135	Paleochannels	0.025	ASTM D5084	Northgate 2010
PC-137	UMCf	0.0030	ASTM D5089	Northgate 2009
PC-137	UMCf	0.0030	ASTM D5084	Northgate 2010
PC-153	UMCf	0.0099	API RP40, Mod. ASTM D425, EPA 9100	[1]
RSAI7-10B	Qal	0.039	ASTM D5084	Northgate 2010
RSAJ3-10BSPLP	Qal	0.26	ASTM D5084	Northgate 2010
RSAJ3-29BSPLP	UMCf	0.013	ASTM D5084	Northgate 2010
RSAL6-0.5BSPLP	Qal	0.17	ASTM D5084	Northgate 2010
RSAL6-28BSPLP	Qal	4.3	ASTM D5084	Northgate 2010
RSAM3-10BSPLP	Qal	0.34	ASTM D5084	Northgate 2010
RSAM3-30BSPLP	UMCf	0.087	ASTM D5084	Northgate 2010
RSAN8-10BSPLP	Qal	0.52	ASTM D5084	Northgate 2010
RSAN8-28BSPLP	Qal	2.3	ASTM D5084	Northgate 2010
RSAQ4-10BSPLP	Qal	0.16	ASTM D5084	Northgate 2010
RSAQ4-32BSPLP	Qal	0.020	ASTM D5084	Northgate 2010
RSAQ8-10BSPLP	Qal	1.2	ASTM D5084	Northgate 2010
RSAQ8-31BSPLP	Qal	0.7	ASTM D5084	Northgate 2010
RSAR3-0.5BSPLP	Qal	0.27	ASTM D5084	Northgate 2010
RSAR3-35BSPLP	Qal	0.042	ASTM D5084	Northgate 2010
RSAU4-20BSPLP	Qal	1	ASTM D5084	Northgate 2010
RSAU4-50BSPLP	UMCf	0.071	ASTM D5084	Northgate 2010
RSAU5-0.5BSPLP	Qal	0.026	ASTM D5084	Northgate 2010
RSAU5-50BSPLP	UMCf	0.16	ASTM D5084	Northgate 2010
SA102-10BSPLP	Qal	0.26	ASTM D5084	Northgate 2010
SA102-30BSPLP	UMCf	0.022	ASTM D5084	Northgate 2010
SA128-10BSPLP	Qal	0.17	ASTM D5084	Northgate 2010
SA128-29BSPLP	UMCf	0.016	ASTM D5084	Northgate 2010

TABLE D-2. SUMMARY OF ESTIMATED VERTICAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Vertical Hydraulic Conductivity (ft/d)	Test Method / Analysis	Report Source[2]
SA148-10BSPLP	Qal	0.46	ASTM D5084	Northgate 2010
SA148-35BSPLP	UMCf	0.022	ASTM D5084	Northgate 2010
SA166-10BSPLP	Qal	0.45	ASTM D5084	Northgate 2010
SA166-31BSPLP	UMCf	0.0060	ASTM D5084	Northgate 2010
SA182-10BSPLP	Qal	1.0	ASTM D5084	Northgate 2010
SA182-38BSPLP	UMCf	0.20	ASTM D5084	Northgate 2010
SA30-35BSPLP	UMCf	0.0430	ASTM D5084	Northgate 2010
SA30-9BSPLP	Qal	0.5900	ASTM D5084	Northgate 2010
SA34-10BSPLP	Qal	0.39	ASTM D5084	Northgate 2010
SA34-31BSPLP	Qal	0.063	ASTM D5084	Northgate 2010
SA52-15BSPLP	Qal	0.44	ASTM D5084	Northgate 2010
SA52-28BSPLP	Qal	1.2	ASTM D5084	Northgate 2010
SA56-10BSPLP	Qal	4.2	ASTM D5084	Northgate 2010
SA56-37BSPLP	UMCf	0.0087	ASTM D5084	Northgate 2010
SA64-10BSPLP	Qal	0.035	ASTM D5084	Northgate 2010
TMSB-132-152C	UMCf	6.2E-05	Falling Head	TIMET 2008
TMSB-132-172C	UMCf	0.0024	Falling Head	TIMET 2008
TMSB-132-92C	UMCf	1.3E-04	Falling Head	TIMET 2008
TMSB-133-157C	UMCf	5.9E-05	Falling Head	TIMET 2008
TMSB-133-162C	UMCf	5.7E-04	Falling Head	TIMET 2008
TMSB-133-164C	UMCf	6.2E-05	Falling Head	TIMET 2008
TMSB-133-50C	xMCf	5.9E-04	Falling Head	TIMET 2008
TMSB-133-68C	xMCf	3.4E-04	Falling Head	TIMET 2008
TMSB-133-89C	xMCf	1.7E-04	Falling Head	TIMET 2008
TMSB-135-108C	UMCf	1.4E-04	Falling Head	TIMET 2008
TMSB-135-126C	UMCf	2.7E-04	Falling Head	TIMET 2008
TMSB-135-145C	UMCf	2.3E-04	Falling Head	TIMET 2008

TABLE D-2. SUMMARY OF ESTIMATED VERTICAL HYDRAULIC CONDUCTIVITY
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Boring ID	Lithology[1]	Vertical Hydraulic Conductivity (ft/d)	Test Method / Analysis	Report Source[2]

Notes:

Qal= Quaternary Alluvium

UMCf = Upper Muddy Creek Formation

xMCf = Transitional Muddy Creek Formation

ft/d = feet per day

[1] Lithologic unit classification for wells was taken from the NDEP All Wells Database or technical report description. Some minor modifications were made as described in Section 1.1.2 of Appendix D.

[2] References for hydraulic properties measured within the Study Area

Sources:

Geraghty & Miller, Inc. 1980 Geraghty & Miller, Inc. 1980. Ground-Water Investigation Stauffer Chemical Company, Henderson, Nevada. October.

Northgate 2009 Northgate. 2009. Interim Groundwater Capture Evaluation and Vertical Delineation Report; Tronox LLC; Henderson, Nevada. December 23.

Northgate 2010 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.

TIMET. 2008. Tasks I, II, and III, Data Transmittal Report in support of the Groundwater Remedial Alternatives Study. May 16.

[1] These data are preliminary results of laboratory physical testing conducted as part of the NERT Remedial Investigation (RI).

TABLE D-3. SUMMARY OF ESTIMATED STORAGE PARAMETERS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Test Location	Aquifer thickness (ft)	Lithology[1]	Specific Yield	Test Type	Analysis	Report Source[2]
AA-08	--	Paleochannels	5.00E-01	Step test	Theis with Jacob Correction	Kleinfelder 2007
AA-08EW	--	Qal	3.85E-03	Step test	Calculation after Theis with Jacob Correction	Kleinfelder 2007
AA-08OEW	--	Qal	5.00E-01	Recovery (pump test)	Calculation after AGARWAL + Theis	Kleinfelder 2007
AA-08OWA	--	Qal	9.20E-02	Constant rate pump test	Calculation after Theis with Jacob Correction	Kleinfelder 2007
AA-08OWA	--	Qal	1.48E-01	Recovery (pump test)	Calculation after AGARWAL + Theis	Kleinfelder 2007
AA-08OWB	--	Qal	2.92E-02	Constant rate pump test	Calculation after Theis with Jacob Correction	Kleinfelder 2007
AA-08OWB	--	Qal	4.09E-02	Recovery (pump test)	Calculation after AGARWAL + Theis	Kleinfelder 2007
AA-09	--	Paleochannels	3.83E-05	Constant Rate Pump Test AA-09 Recovery	Calculation after AGARWAL + Theis with Jacob Correction	Kleinfelder 2007
AA-09	--	Paleochannels	2.27E-03	Step test AA-09C	Theis with Jacob Correction	Kleinfelder 2007
AA-09	--	Paleochannels	3.95E-02	Constant Rate Pump Test	Theis with Jacob Correction	--
AA-09OW	--	Qal	1.91E-02	Recovery (pump test)	--	Kleinfelder 2007
AA-09OW	--	Qal	5.72E-02	Constant rate pump test	Theis with Jacob Correction	Kleinfelder 2007
AA-09OW	--	Qal	6.65E-02	Constant Rate Pump Test AA-09 Recovery	Calculation after AGARWAL + Theis with Jacob Correction	--
AA-20	--	Paleochannels	5.41E-06	Constant rate pump test	Calculation after Theis with Jacob Correction	Kleinfelder 2007
AA-20	--	Paleochannels	1.53E-03	Recovery (pump test)	Calculation after AGARWAL + Theis with Jacob Correction	Kleinfelder 2007
AA-20OW	--	Qal	3.79E-02	Constant rate pump test	theis with Jacob Correction	Kleinfelder 2007
AA-20OW	--	Qal	4.50E-02	Recovery (pump test)	Calculation after AGARWAL + Theis with Jacob Correction	Kleinfelder 2007
AMEW-1	90	UMCf-cg	2.46E-04	Constant Rate Discharge, DX-161A observation	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-1	90	UMCf-cg	5.39E-04	Constant Rate Discharge, DX-161B observation	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-2	40	UMCf-cg	3.25E-04	Constant Rate Discharge, DY-169 observation	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-3	30	UMCf-cg	2.83E-04	Constant Rate Discharge, AMOW-3D observation	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-4	35	UMCf-cg	8.54E-05	Constant Rate Discharge, ADX-135 observation	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-4	35	UMCf-cg	1.96E-04	Constant Rate Discharge, ADX-156 observation	Hantush-Jacob Leaky	AMPAC 2011b
AMEW-5	35	UMCf-cg	9.54E-04	Constant Rate Discharge, AEX-166 observation	Hantush-Jacob Leaky	AMPAC 2011b
AMX-40	--	UMCf	1.00E-03	Pump test (pump from AMX-40)	--	AMPAC 2011a
CLD4-R	9.8	Qal	6.32E-02	--	Theis	Tetra Tech 1998
CLD4-R	9.8	Qal	8.90E-02	--	Neuman	Tetra Tech 1998
DX-161A	--	UMCf-cg	5.00E-04	Pump test (pump from DX-161)	AQTESOLV curve matching	AMPAC 2011a
DX-161C	--	UMCf-cg	3.00E-04	Pump test (pump from DX-161)	AQTESOLV curve matching	AMPAC 2011a
EW-2	--	UMCf-cg	4.00E-04	Pump test (pump from DX-161)	--	AMPAC 2011a
H-14	2	Paleochannels	2.70E-03	drawdown	Theis H-37 obs well	Geraghty & Miller 1980
H-19	8	Qal/UMCf	1.60E-02	drawdown	Theis H-46 obs well	Geraghty & Miller 1980
H-36	11	Qal	5.10E-02	distance drawdown	Jacob	Stauffer 1983
H-36	13	Qal	9.00E-02	delayed yield	Boulton	Stauffer 1983
H-53	16	Paleochannels	6.40E-02	distance drawdown	Jacob	Stauffer 1983
H-53	20	Paleochannels	9.00E-02	delayed yield	Boulton	Stauffer 1983
H-54	20	Paleochannels	3.50E-02	distance drawdown	Jacob	Stauffer 1983
H-54	20	Paleochannels	4.30E-02	distance drawdown	Jacob	Stauffer 1983
H-54	11	Paleochannels	8.30E-02	delayed yield	Boulton	Stauffer 1983

TABLE D-3. SUMMARY OF ESTIMATED STORAGE PARAMETERS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Test Location	Aquifer thickness (ft)	Lithology[1]	Specific Yield	Test Type	Analysis	Report Source[2]
I-AA	--	Qal/UMCf	1.55E-04	Step-drawdown	Moench	Ramboll Environ 2013
I-AB	--	Qal/UMCf	2.00E-02	Step-drawdown	Moench	Ramboll Environ 2013
I-AC	--	Qal/UMCf	5.00E-03	Step-drawdown	Moench	Ramboll Environ 2013
I-AD	--	Qal/UMCf	1.91E-04	Step-drawdown	Moench	Ramboll Environ 2013
I-B	--	xMCf/UMCf	6.61E-04	Recovery test	Moench	Ramboll Environ 2013
I-D	--	Paleochannels	1.44E-04	Recovery test	Moench	Ramboll Environ 2013
I-G	--	UMCf		Recovery test	Moench	Ramboll Environ 2013
I-J	--	UMCf	1.05E-03	Recovery test	Moench	Ramboll Environ 2013
I-K	--	UMCf	2.54E-03	Recovery test	Moench	Ramboll Environ 2013
J2D2-R2	18.7	Qal	1.83E-03	--	Cooper-Jacob	Tetra Tech 1998
M-27	16	Paleochannels	5.30E-02	slug test	Bouwer and Rice, 1976	KMCC 1985
M9	35	NA		--	--	Converse Consultants 1986
OW-1	40	Wash Gravels	1.00E-02	--	Theis-Theoretical Recovery, Graphical Calculation	Converse Consultants 2002
OW-1	40	Wash Gravels	1.80E-01	--	Cooper-Jacob Time-Drawdown, AquiferTest Software	Converse Consultants 2002
OW-1	40	Wash Gravels	2.20E-01	--	Cooper-Jacob Time-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-1	40	Wash Gravels	2.50E-01	--	Cooper-Jacob Time-Dist-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-1	40	Wash Gravels	3.00E-01	--	Hantush-Jacob (leakage), AquiferTest Software	Converse Consultants 2002
OW-2	40	Wash Gravels	7.00E-03	--	Theis-Theoretical Recovery, Graphical Calculation	Converse Consultants 2002
OW-2	40	Wash Gravels	4.00E-02	--	Cooper-Jacob Time-Dist-Drawdown, AquiferTest Software	Converse Consultants 2002
OW-2	40	Wash Gravels	5.00E-02	--	Cooper-Jacob Time-Dist-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-2	40	Wash Gravels	1.40E-01	--	Cooper-Jacob Time-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-3	40	Wash Gravels	2.00E-03	--	Theis-Theoretical Recovery, Graphical Calculation	Converse Consultants 2002
OW-3	40	Wash Gravels	1.00E-01	--	Cooper-Jacob Time-Dist-Drawdown, AquiferTest Software	Converse Consultants 2002
OW-3	40	Wash Gravels	1.20E-01	--	Cooper-Jacob Time-Dist-Drawdown, Graphical Calculation	Converse Consultants 2002
OW-3	40	Wash Gravels	2.20E-01	--	Cooper-Jacob Time-Drawdown, Graphical Calculation	Converse Consultants 2002
P-1	--	Wash Gravels	7.90E-01	Pump test	Jacob straight line	Converse Consultants 1986
P-2	--	Wash Gravels	1.00E-01	Pump test	Jacob straight line	Converse Consultants 1986
P-3	--	Wash Gravels	7.00E-02	Pump test	Jacob straight line	Converse Consultants 1986
PC-19	--	Paleochannels	3.00E-01	Jacobs Semi-Log Drawdown	--	Batista 2003
PC-70	33	Paleochannels	3.00E-02	pumping test- PC-18 obs	Jacobs, drawdown	KMCC 1988
PC-70	37	Paleochannels	3.00E-02	pumping test- PC-55 obs	Theis, drawdown	KMCC 1988
PC-70	33	Paleochannels	3.00E-02	pumping test- PC-17 obs	Theis, drawdown	KMCC 1988
PC-70	37	Paleochannels	4.00E-02	pumping test- PC-55 obs	Boulton, drawdown	KMCC 1988
PC-70	33	Paleochannels	4.00E-02	pumping test- PC-17 obs	Boulton, drawdown	KMCC 1988
PC-70	34	Paleochannels	4.00E-02	pumping test	Distance-drawdown @ 100 min, Jacobs semi-log straight-line	KMCC 1988
PC-70	34	Paleochannels	6.00E-02	pumping test	Distance-drawdown @ 2880 min, Jacobs semi-log straight-line	KMCC 1988
PC-70	34	Paleochannels	8.00E-02	pumping test	Distance-drawdown @ 720 min, Jacobs semi-log straight-line	KMCC 1988
PC-70	33	Paleochannels	8.00E-02	pumping test- PC-17 obs	Jacobs, drawdown	KMCC 1988
PC-70	34	Paleochannels	8.00E-02	pumping test	Distance-drawdown @ 2160 min, Jacobs semi-log straight-line	KMCC 1988

TABLE D-3. SUMMARY OF ESTIMATED STORAGE PARAMETERS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Test Location	Aquifer thickness (ft)	Lithology[1]	Specific Yield	Test Type	Analysis	Report Source[2]
PC-70	33	Paleochannels	8.00E-02	pumping test- PC-18 obs	Theis, drawdown	KMCC 1988
PC-70	33	Paleochannels	9.00E-02	pumping test- PC-18 obs	Boulton, drawdown	KMCC 1988
PC-70	34	Paleochannels	1.00E-01	pumping test	Distance-drawdown @ 1440 min, Jacobs semi-log straight-line	KMCC 1988
PC-70	37	Paleochannels	1.10E-01	pumping test- PC-55 obs	Jacobs, drawdown	KMCC 1988
PC-98R	25	Paleochannels	8.00E-02	tracer & hydraulic tests	Cooper Jacob drawdown, Theis recovery	Montgomery 2000
PC-99R	--	Paleochannels	2.00E-03	tracer & hydraulic tests	Cooper Jacob drawdown, Theis recovery	Montgomery 2000
POD6-R	5.5	Qal	6.19E-03	--	Theis recovery	Tetra Tech 1998
POD8	13.8	Qal	1.40E-02	--	Neuman	Tetra Tech 1998
TMPZ-201	40	xMCF	3.73E-02	drawdown	Hantush-Jacob CMT-102 obs well	TIMET 2009
TMPZ-201	40	xMCF	5.69E-02	drawdown	Hantush - CMT-101 obs well	TIMET 2009
TMPZ-201	40	xMCF	1.00E-01	drawdown	Hantush- CMT-103 obs well	TIMET 2009
TMPZ-204	60	xMCF	4.08E-03	drawdown	Theis- TMPZ-604 obs well	TIMET 2009
TMPZ-204	60	xMCF	7.24E-03	drawdown	Theis- TMPZ-605 obs well	TIMET 2009
TMPZ-204	70	xMCF	8.85E-02	drawdown	Hantush- TMPZ-603 obs well	TIMET 2009
TMPZ-204	60	xMCF	1.00E-01	drawdown	Hantush- TMPZ-111 obs well	TIMET 2009
Athens Road	32	Wash Gravels	7.00E-02	--	--	McGinley 2003
Historic Lateral	38	Wash Gravels	8.00E-02	pumping test	Theis	McGinley 2003
Northeast Corner Birding Preserve	25	Wash Gravels	8.00E-02	--	--	McGinley 2003
Rainbow Gardens	38	Wash Gravels	0.1 -0.22	pumping test	--	McGinley 2003

Notes:

Qal= Quaternary Alluvium

UMCf = Upper Muddy Creek Formation

UMCf-cg = Upper Muddy Creek Formation, coarse-grained

xMCf = Transitional Muddy Creek Formation

ft = feet

-- = not applicable or unavailable

[1] Litholologic unit classification for wells was taken from the NDEP All Wells Database or technical report description. Some minor modifications were made as described in Section 1.1.2 of Appendix D.

[2] References for hydraulic properties measured within the Study Area

Sources:

American Pacific Corporation (AMPAC). 2011a. Semi-Annual Performance (January 1-June 30, 2010) and 2010 Annual Groundwater Monitoring Report. January 12.

AMPAC. 2011b. Remediation System Work Plan for the AMPAC Groundwater Treatment System (AGTS) at Henderson, Nevada. June 2.

Batista, J.R., et al. 2003. The Fate and Transport of Perchlorate in a Contaminated Site in the Las Vegas Valley. March. Prepared for USEPA.

Converse Consultants. 1986. Geotechnical Site Investigation Las Vegas Wash Crossing of the Lass Vegas Valley Lateral Pipeline, Las Vegas, Nevada. June 4. Prepared for Boyle Engineering Corporation.

Converse Consultants. 2002. Geotechnical Data Report: Southern Nevada Water Authority Contract No. 170A, Rainbow Gardens Weir W-3.5 Las Vegas Wash, 1/2 Mile Upstream of Lake Las Vegas, Clark County, Nevada. June 27. Prepared for Boyle Engineering Corporation.

Errol L. Montgomery & Associates, Inc (Montgomery). 2000. Analysis of Rate of Groundwater Movement Based on Results of Tracer and Hydraulic Tests Conducted Between Pittman Lateral and Seep Area, Henderson, Nevada. December 19. Prepared for Kerr-McGee Chemical, LLC.

TABLE D-3. SUMMARY OF ESTIMATED STORAGE PARAMETERS
Phase 6 Groundwater Flow and Transport Model
Nevada Environmental Response Trust Site
Henderson, Nevada

Well or Test Location	Aquifer thickness (ft)	Lithology[1]	Specific Yield	Test Type	Analysis	Report Source[2]

Geraghty & Miller, Inc. 1980. Ground-Water Investigation Stauffer Chemical Company, Henderson, Nevada. October.

Kerr-McGee Chemical Corporation (KMCC). 1985. Geohydrological Investigation Kerr-McGee Chemical Corporation Hendreson Facility. July. Prepared By Hydrology Services Group Assessment and Remediation Department Kerr-McGee Safety and Environmental Affairs Division.

KMCC. 1998. Preliminary Report on a Hydrogeologic Investigation of Channel-fill Alluvium at the Pittman Lateral, Henderson, Nevada. Prepared By Hydrology Services Group Assessment and Remediation Department Kerr-McGee Safety and Environmental Affairs Division.

Kleinfelder. 2007. Implementation of the Revised Aquifer Testing Work Plan: BMI Common Area Eastside, Henderson, Nevada. November 16.

McGinley & Associates (McGinley). 2003. Las Vegas Wash Initial Perchlorate Modeling Report. October 20. Prepared for Nevada Division of Environmental Protection.

Ramboll Environ. 2013 GWETS Optimization Project Report. Excel file.

Stauffer Chemical Company (Stauffer). 1983. 1982 Hydrogeologic Investigation in Support of the Ground-Water Intercept System at Stauffer Chemical Company Henderson, Nevada. March.

Tetra Tech EM Inc. 1998. Draft Environmental Conditions Investigation Report, Titanium Metals Corporation Facility Environmental Conditions Investigation, Henderson, Nevada, Volume 1 of 3. February 20. Submitted to Nevada Division of Environmental Protection.

TIMET. 2009. Design Data Gap Investigation. June 12.

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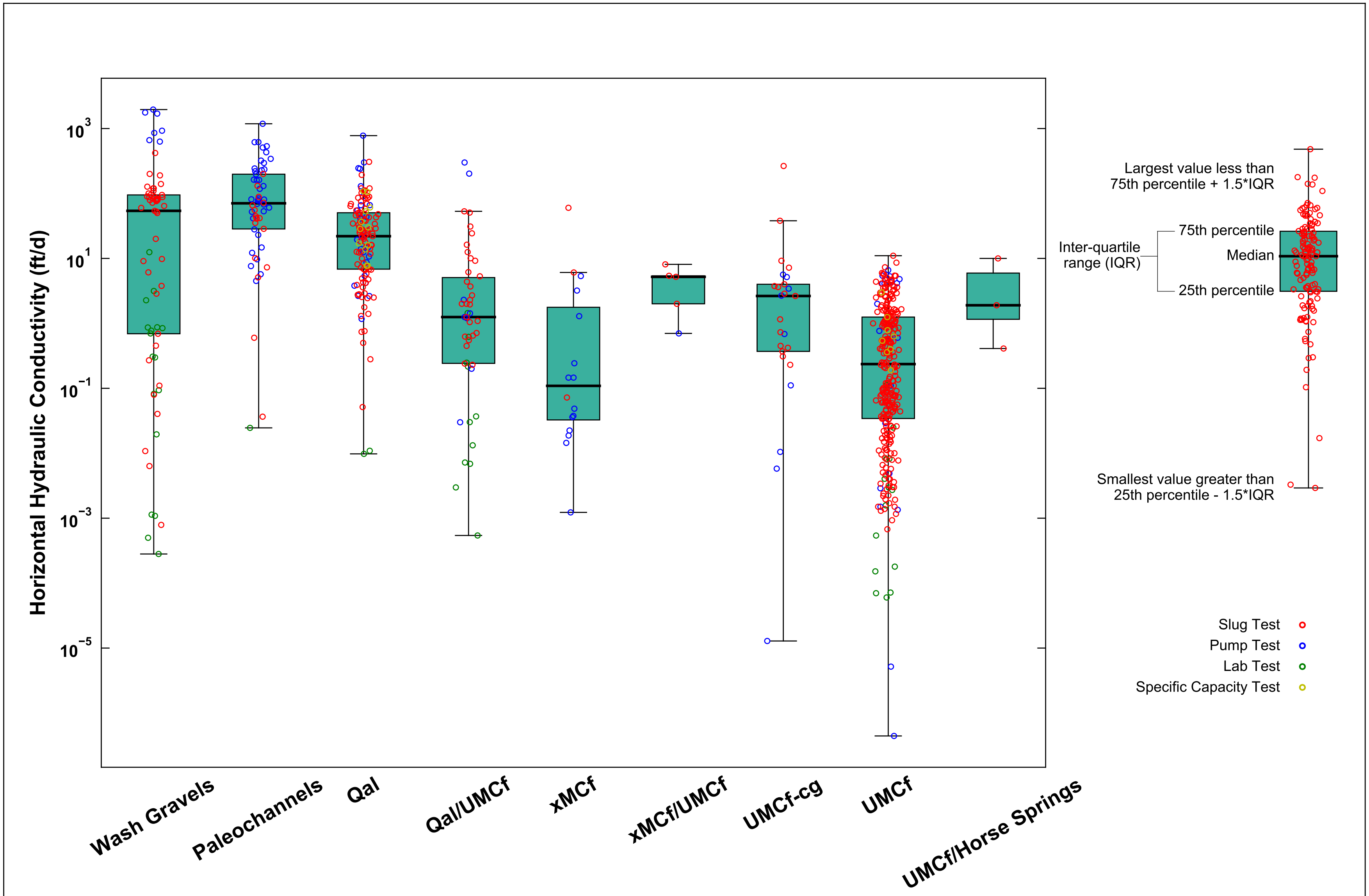

RAMBOLL

Average Hydraulic Conductivity of Lithologic Units
NERT, Henderson, NV

Figure
D-1

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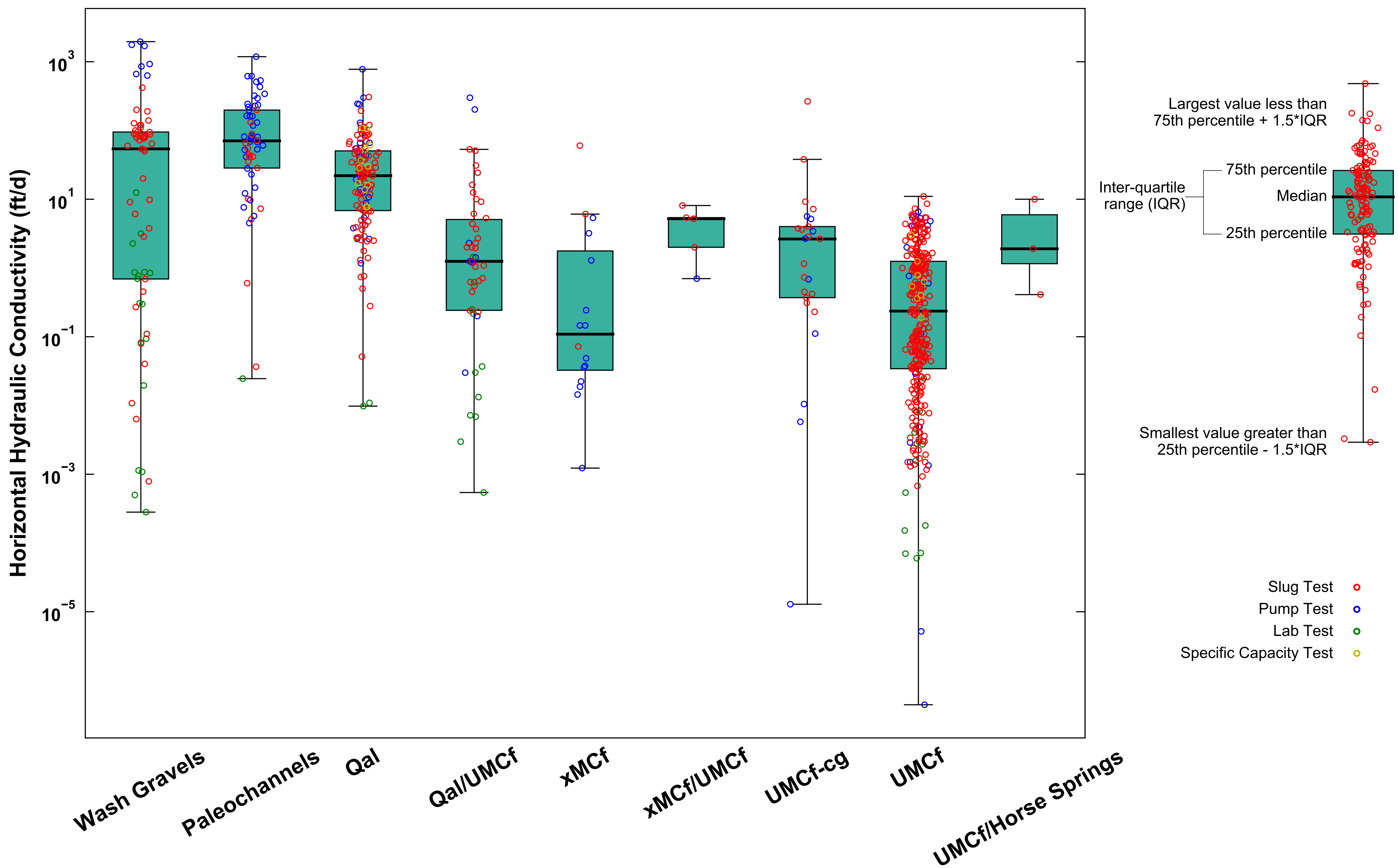

RAMBOLL

Average Hydraulic Conductivity of Lithologic Units
NERT, Henderson, NV

Figure
D-1

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APPENDIX E
OBSERVED GROUNDWATER ELEVATIONS AT CALIBRATION TARGETS (2014-2018) (PROVIDED ELECTRONICALLY)

APPENDIX F
OBSERVED HEAD DIFFERENCE AT CALIBRATION TARGETS (2014-2018)
(PROVIDED ELECTRONICALLY)

APPENDIX G
OBSERVED VERSUS SIMULATED GROUNDWATER ELEVATIONS AT CALIBRATION TARGETS (PROVIDED ELECTRONICALLY)

APPENDIX H
OBSERVED PERCHLORATE CONCENTRATIONS AT CALIBRATION TARGETS (2014–2018) (PROVIDED ELECTRONICALLY)

APPENDIX I
OBSERVED VERSUS SIMULATED PERCHLORATE CONCENTRATIONS AT CALIBRATION TARGETS (PROVIDED ELECTRONICALLY)

APPENDIX J
MODEL FILES (PROVIDED ELECTRONICALLY)