NEVADA DIVISION OF
ENVIRONMENTAL
PROTECTION

STATE OF NEVADA
Department of Conservation & Natural Resources
Joe Lombardo, *Governor*
James A. Settelmeyer, *Director*
Jennifer L. Carr, *Administrator*

May 24, 2023

Chuck Russell
Division of Hydrologic Sciences
Desert Research Institute
755 East Flamingo Road
Las Vegas, Nevada 89119

Re: **Tronox LLC (TRX) Facility**
Nevada Environmental Response Trust (Trust) Property
NDEP Facility ID #H-000539 (DEP # 22-026)
Nevada Division of Environmental Protection (NDEP) Response to *Groundwater Residence Time Distributions within the Nevada Environmental Response Trust (NERT) Site, Henderson, Nevada; Remote Sensing of Evapotranspiration at the Nevada Environmental Response Trust Site and Nearby Properties*

Dated: March 23, 2023

Dear Mr. Russell,

The NDEP has received and reviewed the Desert Research Institute's above-identified Deliverables and provides comments in Attachment A. A revised Deliverable should be submitted by **7/24/2023** based on the comments found in Attachment A. The Desert Research Institute (DRI) should additionally provide an annotated response-to-comments letter as part of the revised Deliverable.

Please contact the undersigned with any questions at wdong@ndep.nv.gov or 702-668-3929.

Sincerely,

Dong Weiquan

Weiquan Dong, P.E.
Bureau of Industrial Site Cleanup
NDEP-Las Vegas City Office

WD:AP

EC:
James Dotchin, NDEP BISC Las Vegas
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Andrew Steinberg, Nevada Environmental Response Trust
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Rosemary W.H. Carroll, Desert Research Institute
Matt Bromley, Desert Research Institute
Susan Rybarski, Desert Research Institute
Ronald L. Hershey, Desert Research Institute
Nicole Damon, Desert Research Institute

Attachment A

Remote Sensing of Evapotranspiration at the Nevada Environmental Response Trust Site and Nearby Properties, dated 03/23/2023

1. The methods used for deriving evapotranspiration for the lower Las Vegas Wash are generally appropriate (Melton et al., 2022). The report should provide clarification of a few details regarding how the results could be used to support the groundwater modeling work.
2. In some areas, the extent of open water in Las Vegas Wash has not been correctly identified. For example, in Figure 1 below, there are black ovals around areas where portions of the Wash open water have been misidentified as areas of evapotranspiration (ETg). This causes the total volume of ETg to be overestimated and the total amount of evaporation to be underestimated. This extent of the Wash will be corrected in the Phase 7 model. As a result, the total volume of ETg will be lower in the Phase 7 model than estimated in the report. Please review the open water for all images used in this report and correct it if it is needed.

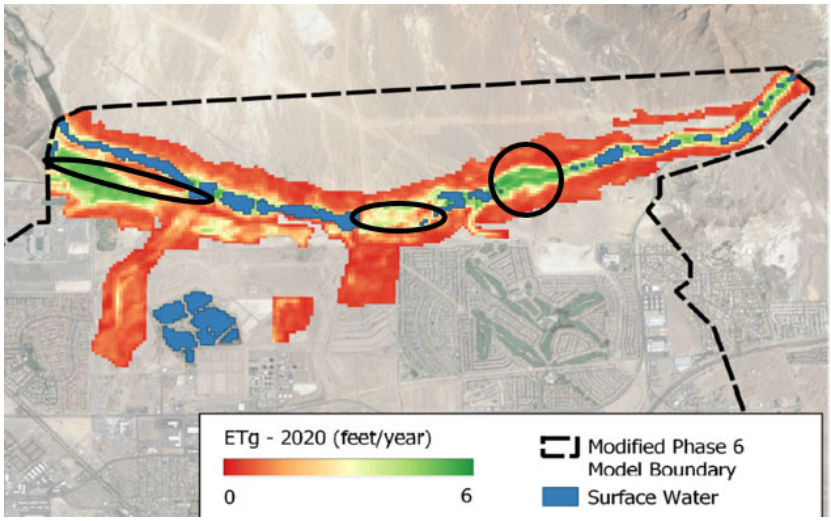


Figure 1: Location of overlapping ETg and the Las Vegas Wash Areas

3. The report might benefit from a more in-depth discussion of the comparison of the results with the Phase 6 model and the potential implications of the estimates for the Phase 7 modeling work (Figure 2).

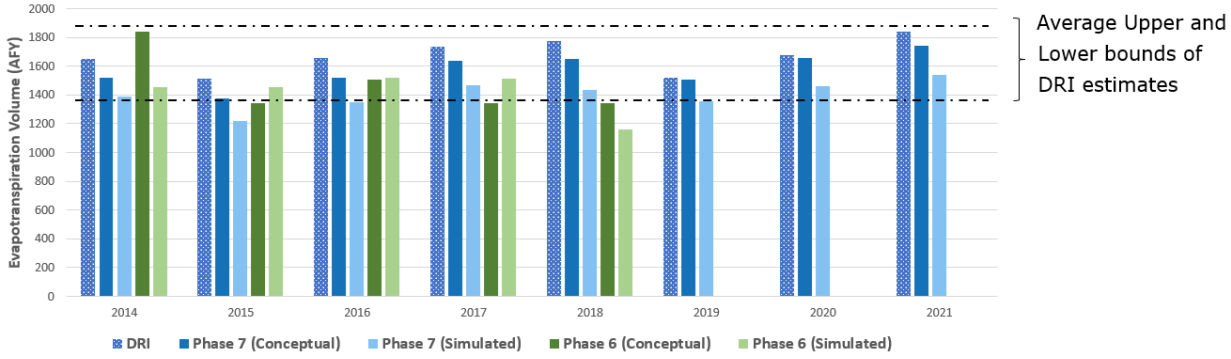


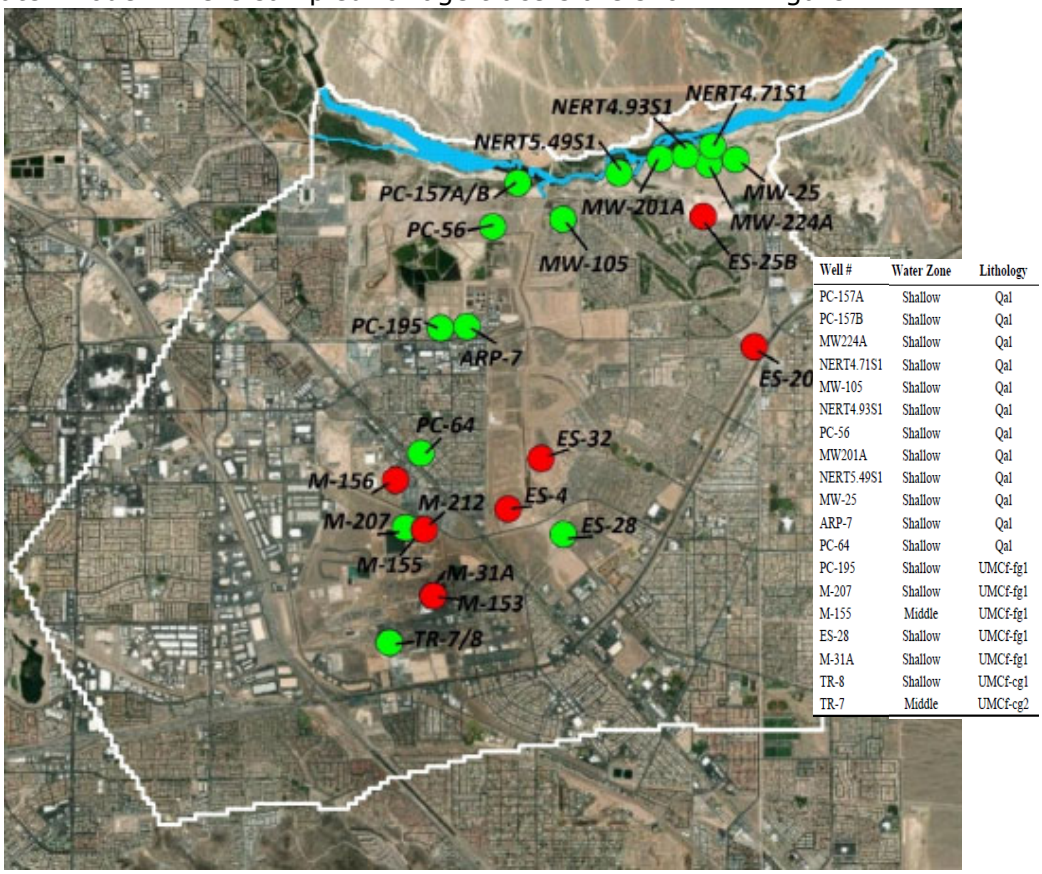
Figure 2: Comparison of the DRI estimates with the Conceptual and simulated ETg estimates from the Phase 6 and the Phase 7 Models

4. The report should explain that some simplification of the results may be necessary when incorporating them into a groundwater model. To limit the complexity of the groundwater model, Ramboll (NERT's Consultant) will use spatially averaged ET parameters for each quarter in the model (parameters will vary with time but not in space). Similarly, for the surface evaporation rates, Ramboll will use the average rates for each quarter in the stream package (SFR) and for the conceptual estimate of recharge from the Bird Viewing Pond (Figure 3). It should be noted that the surface area of the Las Vegas Wash will remain constant throughout the Phase 7 model simulation.

Figure 3: Comparison of the DRI estimates with the Conceptual and simulated ETg estimates from the Phase 6 and the Phase 7 Models

Groundwater Residence Time Distributions within the Nevada Environmental Response Trust (NERT) Site, Henderson, Nevada, dated 03/23/2023

1. The report is comprehensive but would benefit from a clear summary of age-dating results for each well that was sampled using methods that do not rely on comparison to the Phase 6 groundwater model. As described below, there are significant limitations to the approach of attempting to interpret age tracer results using the Phase 6 groundwater model. Wells sampled for age tracers are shown in Figure 4.



Well #	Water Zone	Lithology
PC-157A	Shallow	Qal
PC-157B	Shallow	Qal
MW224A	Shallow	Qal
NERT4.71S1	Shallow	Qal
MW-105	Shallow	Qal
NERT4.93S1	Shallow	Qal
PC-56	Shallow	Qal
MW201A	Shallow	Qal
NERT5.49S1	Shallow	Qal
MW-25	Shallow	Qal
ARP-7	Shallow	Qal
PC-64	Shallow	Qal
PC-195	Shallow	UMCf-fg1
M-207	Shallow	UMCf-fg1
M-155	Middle	UMCf-fg1
ES-28	Shallow	UMCf-fg1
M-31A	Shallow	UMCf-fg1
TR-8	Shallow	UMCf-cg1
TR-7	Middle	UMCf-cg2

Figure 4: Location of Selected Wells for the Study

2. This study extensively uses the approach of attempting to replicate groundwater ages estimated from age tracers measured in shallow monitoring wells with ages estimated using the Phase 6 groundwater model. For the study area, this approach has significant limitations because the historical hydrologic conditions were dramatically different than the current hydrologic conditions that the Phase 6 model was designed to simulate. Most significantly, the widespread use of surface disposal of wastewater into ponds and ditches during the period of the 1940s to 1970s resulted in recharge into shallow groundwater of young water (<70 years old) essentially throughout the entire study area (Figure 5). Of course, it was this historical wastewater disposal that also largely caused the widespread contamination of groundwater. The current plumes of contamination are direct evidence of the extent and persistence of the historical recharge of young water. This historical recharge is not represented by the Phase 6 groundwater model because the model was designed to simulate current conditions (2004-present) after surface disposal of wastewater had largely ceased. As a result, the groundwater ages in shallow wells predicted by the Phase 6 model are generally much

longer than those estimated from age tracers. The report does not fully acknowledge the limitations of the approach of comparing age tracer and model results, and it incorrectly implies that the discrepancy in groundwater ages between age tracers and the model indicates flaws in the groundwater model. On the contrary, the discrepancy points out the limitations of the approach of trying to match a model that only simulates current hydrologic conditions.

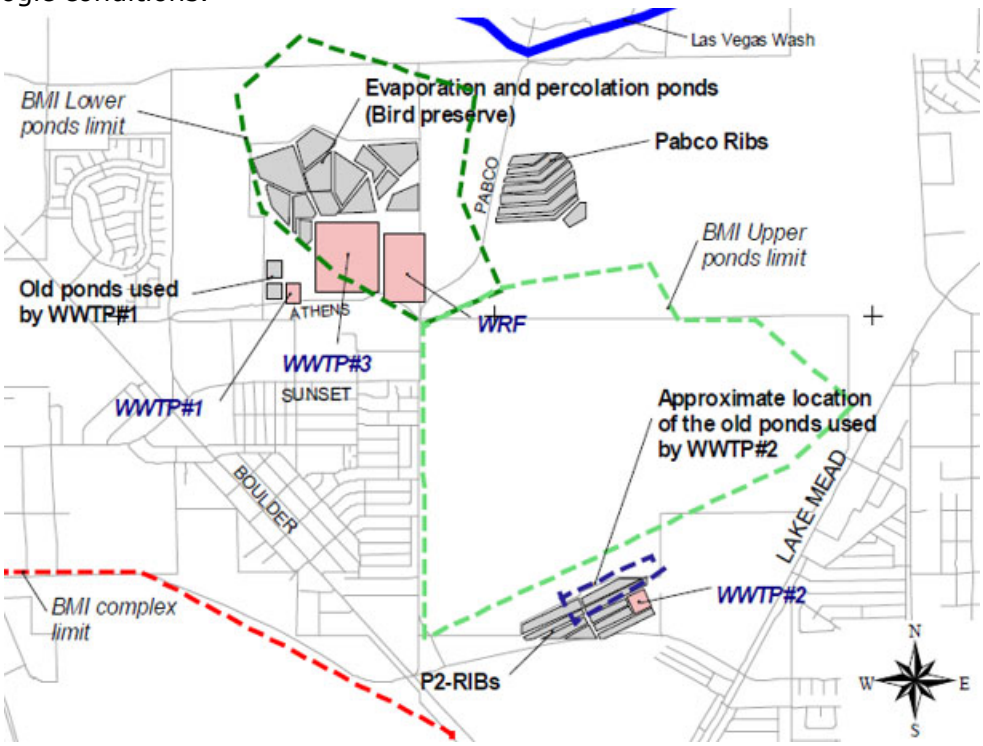


Figure 5: Location of Wastewater Discharge Ponds (1945-1990)

3. This study uses a similar approach to evaluate the amount of surface water-groundwater interaction predicted by the Phase 6 groundwater model. Age tracer results indicate that shallow wells next to Las Vegas Wash largely contain young water (<70 years old). This is expected given that Las Vegas Wash contains young water and there is significant interaction between surface water and shallow groundwater within the Wash fluvial channel. The Phase 6 groundwater model was run in steady-state mode to estimate groundwater ages near the Wash for comparison to the age tracer results. In general, the model predicted smaller proportions of young water than observed. The report implies that this may represent a flaw in the representation of surface water-groundwater interaction in the model. However, there are significant limitations to this approach which should be acknowledged in the report. First, the model was run in steady-state mode which will underestimate the amount of surface water-groundwater interaction that is caused by seasonal fluctuations in precipitation, evapotranspiration, and surface water flows. Second, the model was not designed to represent the significant surface water-groundwater interaction caused by diurnal flow variation in Las Vegas Wash resulting from variation in wastewater effluent discharges. Third, the model was not designed to represent episodic increased surface water-groundwater interaction caused by high-flow events (i.e., flooding). Fourth, the reverse particle tracking approach from only losing stream cells may overestimate travel times. Finally, as noted in comment #2, the age of the groundwater within the study area was affected by

historical surface wastewater disposal that is not accounted for in the Phase 6 model. As a result, there are significant limitations to the approach of comparing the ages predicted by the groundwater model to the ages based on age tracers. The model was calibrated to correctly represent the amount of perchlorate that enters the Wash from groundwater. Given the purpose of the model, this approach is considered to be more reliable.

4. In contrast to the Phase 6 model, a general head boundary (GHB) is being implemented at the bottom of the Phase 7 model to refine the vertical fluxes. Although done for a different purpose, it is likely that this change would improve the match between model predicted ages and tracer study ages.

5. NDEP suggests that the report be revised to acknowledge the limitations of the approach of directly comparing the groundwater ages from the tracer study with the ages estimated using the Phase 6 groundwater model. In particular, recommendations for changes to the Phase 6 model should be qualified based on these limitations.

Reference

Melton, F.S., J. Huntington, R. Grimm, J. Herring, M. Hall, D. Rollison, T. Erickson et al. 2022. "OpenET: Filling a Critical Data Gap in Water Management for the Western United States." Journal of the American Water Resources Association 58 (6): 971–994. https://doi.org/10.1111/1752-1688.12956.ence