

Nevada Environmental Response Trust
35 E. Wacker Drive, Suite 690
Chicago, IL 60601

Subject:

Arcadis Comments on the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum and the Associated Cost Basis Nevada Environmental Response Trust Site Henderson, Nevada

Dear Mr. Clough:

Arcadis U.S., Inc. (Arcadis) has prepared the enclosed technical memorandum (memo) at the request of the Nevada Environmental Response Trust (NERT). The memo summarizes technical comments and observations associated with Arcadis' review of the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum and the Unit 4 Source Area In-Situ Bioremediation Treatability Study Phase 2 Cost Estimate and Basis authored by Tetra Tech, Inc.

Arcadis appreciates the opportunity to provide this review. If there is any questions or comments, please contact the undersigned.

Sincerely,



Jo Wang, PE, CEM (#2125)
Principal Environmental Engineer



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Associate Vice President

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July 21, 2021

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MEMO

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From:

Jeffrey McDonough, Arcadis
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Date:

July 21, 2021

Arcadis Project No.:

30084088

Subject:

Arcadis Third-Party Review of the Unit 4 Source Area In-Situ Bioremediation
Treatability Study Work Plan Addendum and the Associated Cost Basis

At the request of the Nevada Environmental Response Trust (NERT or the Trust) Arcadis North America, Inc. (Arcadis) respectfully submits this technical memorandum (memo) documenting a third-party review of the Unit 4 Source Area In-Situ Bioremediation Treatability Study Work Plan Addendum (Work Plan Addendum) and the Unit 4 Source Area In-Situ Bioremediation Treatability Study Phase 2 Cost Estimate and Basis (Cost Basis). The documents were authored by Tetra Tech, Inc. (Tetra Tech). If the entirety of the Work Plan Addendum is implemented, we agree that the cost basis is aligned with the proposed scope of work.

The high concentration of total dissolved solids (TDS) within the Unit 4 Source Area clearly distinguishes this implementation of bioremediation from other implementations at the NERT site. Through two rounds of collaborative technical review with Arcadis, NERT, and Tetra Tech, we have agreed that due to the severity of the adverse influence of high concentrations of TDS observed in the Phase I Bench-Scale Testing, there is merit in focusing on the ability to reduce TDS by separating the groundwater hydraulics from the implementation of in-situ bioremediation and proceeding in a stepwise fashion. An adaptive approach and a longer period of TDS-focused testing is reflected in the Work Plan Addendum. Depending on data analysis and potentially further technical collaboration, the entirety of the bioremediation scope within the Work Plan

Addendum may not be implemented. We are also in agreement that the Phase I Bench-Scale Testing results summarized in the Work Plan Addendum support and necessitate moving to a field study.

HYDROGEOLOGICAL MODEL REVIEW AND COMMENT

At the request of the Trust, Arcadis reviewed the hydrogeological modeling evaluation and estimated flow rates discussed in the Work Plan Addendum.

Four extraction wells screened in the intermediate zone, each extracting approximately 3 gallons per minute (gpm) is expected to yield approximately 12 gpm cumulatively based upon the longer-term extraction test data from Area 1 (Figure 40 and Appendix D and E in the Work Plan Addendum). It is noted that intermediate zone extraction well U2-E-02I produced more than 6 gpm for approximately 48 hours, and therefore the total yield for the four extraction wells may initially exceed 12 gpm.

Two extraction wells screened in the deep zone, each extracting approximately 1 gpm would yield an additional 2 gpm cumulatively. This average extraction rate is based on the deep zone extraction well yields being lower than in the intermediate zone at between 0.3 and 1.7 gpm (average 1 gpm).

Combining these extraction flow rates (Area 1 and Area 2, intermediate and deep) would result in a total extraction rate of 14 gpm. However, we agree that discounting this total extraction flow rate to approximately 12 gpm as stated in the Work Plan Addendum is the likely result. It is noteworthy to mention that total extraction flow rates may decline further over the testing period as is commonly observed in low yield extraction wells. The following notes offer observations that may be useful for discussion or consideration.

- Hydraulic response to extraction from a single intermediate or deep zone well is seen at monitoring wells screened in each of these zones (Appendix D). This hydraulic connection between the intermediate and deep zones may limit the maximum extraction rate achievable when 6 extraction wells are running simultaneously as planned for the TS. This is because there is a limited volume of groundwater available under these aquifer conditions. These scenarios were modeled and appear to work with 12 gpm and injections will add water to the aquifer, but the 12 gpm extraction rate may not be maintained over the duration of the testing period. This could have an influence either on the cost to complete the scope as written or adaptation of the achievable objectives for a similar cost.
- Based on this hydraulic connection, operation of simultaneous injection and extraction at both Areas 1 and 2 at the same time is a complex system to monitor and optimize. Conducting the test in this manner will make understanding of the respective hydraulic influences challenging. A phased approach, such as a single zone in a single Area, may help to better understand the hydraulic influence of that specific action. A phased approach may avoid unexpected surprises, such as pulling injected water south to Area 2 extraction wells rather than Area 1 extraction wells pulling water north as the model predicts. This would require a longer implementation schedule but should not grossly influence the costs.
- If there are any plans to rotate extraction wells to injection wells (or vice versa), there is likely to be immediate fouling even with aggressive and frequent well development. The achievable (and predicted) extraction rates at all extraction wells are already low and would be expected to diminish over time after they are used as injection wells. This also influences the ex-situ management of diluted molasses.

CLOSING COMMENTS

Arcadis appreciates the opportunity to review the Work Plan Addendum and the Cost Basis. The proposed Work Plan Addendum describes the Unit 4 Source Area Phase II Bioremediation Treatability Study in which molasses will be circulated using one, or potentially two, injection and extraction systems. The Cost Basis provided assumes the entirety of the Work Plan Addendum will be implemented, and, if that is the case, we agree the costs are reasonable. If the decision logic detailed within Sections 4.2.4 and 4.2.5 of the Work Plan Addendum dictates bioremediation is not necessary within both Areas, then the costs will be correspondingly lower. If there are questions or comments associated with this memo, the Trust is encouraged to contact Arcadis.