CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LAHONTAN REGION

MEETING OF MARCH 9-10, 2022
VIDEO/TELECONFERENCE

ITEM 10
LEVIATHAN MINE UPDATE

CHRONOLOGY	
1984 - 1985	State of California acquires the Leviathan Mine site and completes the Leviathan Mine Pollution Abatement Project (e.g., lined evaporation ponds, twin culverts and concrete-lined channel for Leviathan Creek; Pit Underdrain). See Enclosure 1 for Leviathan Mine Site Map.
1999 - 2000	Water Board conducts Pond Water Treatment Pilot Project. Water
2000	USEPA places Leviathan Mine of the National Priorities List (federal Superfund site).
2001 - Current	Water Board continues year-round capture and seasonal treatment of acid mine drainage (AMD) from Adit and Pit Underdrain using Pond Water Treatment system.
2018	Atlantic Richfield propose an Early Final Remedial Action for treating the five primary AMD sources for pH and select metals.
June 21, 2019	Water Board submits potential Applicable or Relevant and Appropriate Requirements (ARARs) from the Water Board and other state agencies as requested by USEPA.
June 23, 2021	USEPA directs Atlantic Richfield (AR) to submit a Focused Feasibility Study (FFS) and a Technical Impracticability Evaluation (TIE) for Operable Unit 1 (OU-1) addressing select metals in surface water and groundwater. OU-1 includes surface water, as originally proposed, and adds addressing groundwater.
August 6, 2021	AR submits the FFS for OU-1 Mine Influenced Groundwater and Metals in Surface water.
September 30, 2021	AR submits Technical Impracticability Evaluation (TIE) Early Final Remedial Action for OU-1, Leviathan Mine, Alpine County
January 14, 2022	Water Board submits comments on the FFS and TIE to USEPA

BACKGROUND

Under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), an Early Final Remedial Action (EFRA) can be implemented as a means to achieve significant risk reduction, address immediate risks to human health and the environment, or to control migration of contamination before the sitewide Remedial Investigation/Feasibility Study is completed. A milestone in the EFRA process is the preparation of a Focused Feasibility Study (FFS). Under CERCLA, the FFS is intended to document the remedial action objectives of the EFRA, identify the Applicable or Relevant and Appropriate Requirements (ARARs), identify and screen technologies, and evaluate alternatives. Water Board staff has reviewed the August 6, 2021 FFS and submitted the Water Board's comments regarding the FFS on January 14, 2022 (Enclosure 3). The FFS proposes a Recommended Alternative that is a significant change in the way the site operates. The Recommended Alternative proposes year-round capture of the five primary sources of acid mine drainage (AMD) using the existing lined evaporation ponds and the ability for year-round treatment using a new centralized high-density sludge (HDS) lime treatment facility that would replace the three existing AMD treatment systems, construction and operation of an onsite sludge waste management unit located in the pit, and access road improvements and providing grid-based power for the site.

AR also submitted a TIE meant to demonstrate how certain metals in effluent cannot be treated to meet water quality objectives and how groundwater at the site cannot be restored to achieve any water quality objectives. Water Board staff has conducted a detailed review of the TIE and submitted the Water Board's comments to USEPA (Enclosure 4) on January 14, 2022. The Water Board in its comments to USEPA has identified significant issues regarding the FFS and the TIE that need to be resolved prior to a Record of Decision being issued.

The purpose of this presentation is to inform the Water Board of these proposed changes and challenges at Leviathan Mine and receive support and any additional direction in terms of next steps.

ISSUES

The EFRA, as currently proposed in the FFS, presents several key challenges for the Water Board. Some of these challenges include:

- **ARARs** – Atlantic Richfield has identified a significantly smaller list of potential ARARs than the State's list of potential ARARs submitted to USEPA. Some of the State's potential ARARs that Atlantic Richfield does not identify in the FFS include, but are not limited to:

    - numerical water quality objectives for Leviathan Creek; and
    - the State Water Board's Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, 2005.

ISSUES

Atlantic Richfield through the TIE is also proposing a waiver of portions of Resolution No. 92-49, that are directly related to establishing cleanup levels for both surface water and groundwater. Water Board staff anticipates that there will be future discussions with USEPA regarding ARARs prior to USEPA releasing a Proposed Plan for the EFRA.

- **Incorporating Groundwater into the EFRA –** Originally, the EFRA was focused solely on year-round capture and treatment of the five primary AMD sources for pH and a select group of metals. Subsequently, Atlantic Richfield introduced treating the five primary AMD sources as the remedial action for addressing groundwater. Doing so has significantly increased the complexity and challenge of evaluating the EFRA given the unresolved issues regarding characterizing the nature and defining the extent of mining-related groundwater impacts, the proposed manner in which to define the extent of mine-influenced groundwater, and the current state of knowledge regarding how groundwater moves into, through, and out of the mine site's influence. Resolving these issues will require additional discussion among the Water Board, USEPA, and Atlantic Richfield, as well as additional evaluation.

- **Onsite Sludge Disposal vs. Offsite Sludge Disposal –** The FFS currently proposes onsite sludge disposal, which is a significant departure from the current practice of transporting sludge generated by the Water Board's and Atlantic Richfield's treatment facilities to U.S. Ecology's waste disposal site in Beatty, Nevada. The sludge is currently characterized as a non-RCRA hazardous waste. If sludge from the proposed HDS treatment facility is also characterized as hazardous waste, disposing of the sludge onsite places the State, as landowner and facility operator, in the position of owning, operating, maintaining, and being responsible for regulatory compliance of a hazardous waste disposal facility in perpetuity. Additional site analysis will also need to be conducted to determine if locating a sludge disposal facility onsite satisfies state siting criteria among other prescriptive requirements.

DISCUSSION

The Staff Report (Enclosure 2) identifies the major issues and potential pathways forward Water Board staff has identified with the EFRA FFS and TIE submitted by Atlantic Richfield. Water Board staff has been working on these and other issues; but doing so from a unique position that creates some challenging dynamics. For example, while Atlantic Richfield is under a USEPA order to complete Remedial Investigation/Feasibility Study activities, the Water Board is responsible for designing, constructing, operating, and maintaining all remedial actions approved by USEPA via Records of Decision pursuant to the 2015 Settlement Agreement between the State of California and Atlantic Richfield. The Water Board will also be the party that is responsible for complying with future USEPA requirements regarding remedial actions and their performance (e.g., new HDS treatment facility effluent limitations).

DISCUSSION

So, one party (Atlantic Richfield) is proposing remedial actions that another party (Water Board) will, upon USEPA approval, be responsible for implementing, operating and maintaining, and complying with regulatory requirements related to their performance.

It is under this unique set of conditions that Water Board staff is reviewing and commenting upon CERCLA documents, such as the FFS and TIE. Water Board staff finds itself simultaneously wearing multiple hats related to its multiple roles and responsibilities. Some examples of those multiple roles and responsibilities include the Water Board being (1) a responsible party subject to regulation and oversight by USEPA; (2) responsible for ensuring the State's environmental and regulatory interested are being represented throughout the CERCLA process, and (3) responsible for evaluating Atlantic Richfield's remedial action proposals to ensure they will be protective of human health and the environment and are consistent with State laws, policies, and regulations, can be constructed, and make operational sense on a long-term basis.

Next steps for Water Board staff include:

- Continuing to meet with USEPA, Atlantic Richfield, and stakeholders to work towards resolving the issues outlined, above, and in the Staff Report. The goal is to have a Proposed Plan containing a Final Feasibility Study that provides adequate flexibility to address some of the issues during remedial design, and requirements to conduct additional investigation/analysis for generating the information and data needed to demonstrate decisions regarding TI waivers and other issues are technically and legally sound.
- Briefing State Water Board and CalEPA Managers and Executives regarding the issues outlined above and discussed in the Staff Report.
- Engaging State Water Board, CalEPA, and the Department of Finance in securing the necessary financial resources that will be needed for future design, construction, and operation and maintenance costs.
- Continuing to update the Water Board regarding the EFRA's and site-wide Remedial Investigation/Feasibility Study's progress through the CERCLA process.

SUSTAINABLE GROUNDWATER MANAGEMENT ACT BASINS

For purposes of the Sustainable Groundwater Management Act, the California Department of Water Resources identifies the following groundwater basin in Alpine County, along with priority, near the discharge location within the Lahontan Region.

Priority	Groundwater Basin
Very Low	Carson Valley (6-006)

Source: Sustainable Groundwater Management Act Basin Prioritization

CLIMATE CHANGE RESPONSE
The proposed EFRA includes elements that should be consistent with or address in some manner the following key resource areas identified in the Water Board's Climate Change Mitigation and Adaptation Strategy (Resolution R6T-2019-0277): (1) Protection of Wetlands, Floodplains, and Headwaters; (2) Infrastructure Protection; (3) Protection of Groundwater Quality and Supply; and potentially (4) Protection of Headwater Forests and Promoting Fire Resilient Landscapes.

PUBLIC OUTREACH/INPUT
USEPA, Atlantic Richfield, and stakeholders have been notified and provided a copy of this agenda item and invited to attend the Board meeting.

PRESENTERS
Catherine Pool, Lahontan Water Board, Senior Water Resource Control Engineer Scott C. Ferguson, Lahontan Water Board, Supervising Water Resource Control Engineer

RECOMMENDATION
This is an informational item and no formal action is requested, though the Water Board members may give direction to staff.

ENCLOSURE	ITEM	BATES NUMBER
1	Leviathan Mine Site Map	**10 - 6**
2	Staff Report	**10 - 8**
3	January 14, 2022 Water Board Comment Letter Re: Focused Feasibility Study for EFRA OU-1, Leviathan Mine	**10 - 31**
4	January 14, 2022 Water Board Comment Letter Re: Technical Impracticability Evaluation for EFRA OU-1, Leviathan Mine	**10 - 101**

ENCLOSURE 1

Leviathan Mine Site Map

ENCLOSURE 2

Report to the Lahontan Regional Water Quality Control Board
March 9-10, 2022 Board Meeting, Agenda Item No. 10

2022 Leviathan Mine Update

Executive Summary

Leviathan Mine is a former open-pit sulfur mine located in eastern Alpine County that the State of California acquired in the early 1980s to address water quality problems caused by historical mining. Jurisdiction over Leviathan Mine rests with the State Water Resources Control Board, which in turn has delegated jurisdiction over cleanup work to the California Regional Water Quality Control Board, Lahontan Region (Water Board). Since the mid-1980s, the Water Board has implemented numerous pollution abatement projects and currently provides year-round capture and seasonal treatment of acid mine drainage (AMD) from the mine site's two most polluted AMD sources (the Adit and Pit Underdrain). On May 11, 2000, the United States Environmental Protection Agency (USEPA) placed Leviathan Mine on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List, thus making Leviathan Mine a federal Superfund site.

Atlantic Richfield, a former mine site owner, also has and continues to implement pollution abatement activities at the mine site, including providing year-round capture and treatment of the Aspen Seep AMD source and seasonal capture and treatment of AMD from the Delta Seep and Channel Underdrain. Both the Water Board and Atlantic Richfield are under USEPA orders to operate and maintain their AMD capture and treatment systems and to meet USEPA discharge criteria for discharging treated AMD to Leviathan Creek and Aspen Creek. See Figure 1 for Leviathan Mine site map.

Atlantic Richfield is also under a USEPA order to conduct a Remedial Investigation to characterize the nature and extent of impacts from mining activities and to prepare a Feasibility Study to evaluate alternative remedial actions for addressing the impacts of mining activities at the site on human health and the environment. Approximately two years ago, Atlantic Richfield proposed developing an Early Final Remedial Action (EFRA) for year-round capture of the five AMD sources identified above, and treatment for a select group of metals prior to discharging the treated AMD to Leviathan Creek.

The premise behind pursuing the EFRA now is to improve surface water quality sooner, rather than waiting for a remedy to be developed and implemented that addresses all impacts associated with the entire mine site and downstream areas affected by mining activities. The Water Board and USEPA agreed with the EFRA proposal in general and have been working with Atlantic Richfield since.

In a June 23, 2021 letter, USEPA found that there was sufficient information available and directed Atlantic Richfield to prepare a draft Focused Feasibility Study (FFS) and Technical Impracticability Evaluation (TIE) for Operable Unit 1 (OU-1). The draft FFS defines OU-1 as (1) groundwaters and surface waters in the Leviathan Creek watershed and (2) surface water in Bryant Creek downstream to the East Fork Carson River. On August 6, 2021, Atlantic Richfield submitted its Focused Feasibility Study for OU-1 Mine-Influenced Groundwater and Metals in Surface Water and on September 30, 2021, Atlantic Richfield submitted its Technical Impracticability Evaluation Early Final Remedial Action for Operable Unit 1. Both documents were prepared by Wood Environment & Infrastructure Solutions, Inc. on behalf of Atlantic Richfield. Water Board staff reviewed both documents and submitted comments to USEPA on January 14, 2022.

The Water Board's comments identify a number of issues with the analysis and conclusions of the FFS and TIE elements. The Water Board also identified potential courses of action that could allow the EFRA to continue moving through the CERCLA process while USEPA, Atlantic Richfield, and the Water Board work on addressing the issues identified in the Water Board's comment letters. Additional information regarding Water Board issues and concerns, in addition to the possible pathway forward, is discussed below.

Section 1: Focused Feasibility Study

Early Final Remedial Action and Focused Feasibility Study Overview

Under the CERCLA, an EFRA can be implemented to achieve significant risk reduction, address immediate risks to human health and the environment, or to control migration of contamination before the sitewide Remedial Investigation/Feasibility Study is completed. Under CERCLA, the FFS is intended to document the objectives of the EFRA, identify the Applicable, or Relevant and Appropriate Requirements (ARARs), identify and screen technologies, evaluate alternatives, and provide a recommended alternative.

Remedial Action Objectives and ERFA Components

The overall objectives of the EFRA when first presented by Atlantic Richfield were to achieve year-round capture of the five primary AMD sources and be able to perform

year-round AMD treatment for a select group of metals.[1] Subsequently, Atlantic Richfield introduced the concept that the EFRA would also serve as the final remedial action for addressing groundwater impacted by mining activities. While Water Board staff has continued to work with USEPA and Atlantic Richfield as the EFRA's objectives evolved, Water Board staff has consistently advised USEPA of the challenges associated with identifying the EFRA as the final remedial action for groundwater contamination. Some of these complexities and challenges include, but are not limited to, difficulties in delineating the vertical and lateral extent of groundwater contamination in a highly altered and hydrogeologically complex area, and evaluating State Water Board Resolution No. 92-49.

Water Board staff requested the original remedial objectives be retained in the EFRA, but Atlantic Richfield continued to advocate for the EFRA to serve as the remedial action for groundwater impacted by mining activities. USEPA in its June 23, 2021 letter directed Atlantic Richfield to develop the draft FFS with the following OU-1 definition:

- All water within the Leviathan Creek Watershed and the surface water in Bryant Creek downstream to the East Fork of the Carson River.

The draft FFS also proposes the following Remedial Action Objectives:

- Prevent unacceptable exposure of human and aquatic organisms to acidity (pH) and AMD metals in surface water associated with the former Leviathan Mine.
- Prevent unacceptable human exposure through ingestion and dermal contact to mining-impacted groundwater.

In response to the proposed Remedial Action Objectives and following technology screening and alternatives analysis, Atlantic Richfield identified the following components for the EFRA in the Recommended Alternative:

- Collect AMD year-round using the existing AMD-capture systems at the five primary AMD discharge locations.
- Deepen Pond 2S to achieve a total storage volume of about 23.8 million gallons (MG) (an increase of about 8.4 MG) and reconstruct Pond 2S with an upgraded dual-liner system and leachate collection and recovery system.
- Maintain the other four ponds (Pond 1, Pond 2N, Pond 3, and Pond 4) in their current configurations.

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[1] Currently, untreated AMD is seasonally (typically mid-October to mid-May) discharged from the Delta Seep and Channel Underdrain AMD sources to Leviathan Creek.

- Store AMD in the five ponds prior to treatment.
- Use pipelines to convey AMD from AMD-capture systems to storage ponds, between storage ponds, and from storage ponds to the treatment plant.
- Construct a new AMD-conveyance system from Aspen Seep to Pond 1.
- Construct and operate a new centralized high-density sludge (HDS) treatment plant located near Pond 4 capable of year-round treatment of AMD metals.
- Construct and operate a new sludge repository in the pit and a new access road into the pit (onsite sludge disposal).
- Construct and operate a new pumping system and pipeline (two redundant lines) to convey sludge slurry from the new HDS treatment plant to the sludge repository.
- Construct and operate a new pumping system and pipeline to convey decant water from the sludge repository for discharge to Leviathan Creek.
- Construct improvements to the Nevada access road to provide for safe, year-round access to the mine site and support for year-round treatment operations.
- Install a grid power line along the Nevada access road.
- Install an improved communications system.
- Construct an emergency shelter/office building.

Atlantic Richfield also identified the following Institutional Controls as part of the EFRA Recommended Alternative intended to assist in satisfying the Remedial Action Objectives referenced above:

- OU-1 Surface Water Institutional Control - Signage that will be placed at appropriate locations along Leviathan Creek and Bryant Creeks advising against human activity that could result in unacceptable exposure to contaminated surface water.
- OU-1 Groundwater Institutional Control - Use restrictions in the form of environmental covenants prohibiting installation of onsite groundwater wells for domestic use.

It is also important to note what the EFRA does not address including, but not limited to:

- Treatment of the five primary AMD sources for reducing sulfate and total dissolved solids concentrations prior to discharge to Leviathan Creek.
- Remedial actions (e.g., revegetation, stormwater management, regrading) intended to reduce infiltration and AMD production, which in turn could reduce the extent of mine-influenced groundwater.

- Stream and floodplain sediments containing mine waste.
- Mine waste.

These and other elements will be addressed through the site-wide remedial investigation/feasibility study elements of the CERCLA process, even though some of them could affect groundwater conditions (e.g., infiltration reduction potentially reducing the extent of mining-related impacts to groundwater) and surface water conditions (e.g., stream sediments containing mine waste that can adversely affect Leviathan Creek water quality downstream of the mine site) currently being evaluated in response to the request for TI waivers. It is currently unclear how these and similar situations will be addressed in the Proposed Plan and Record of Decision, so that the EFRA does not preclude future remedial actions from addressing conditions still under investigation and evaluation through the ongoing site-wide remedial investigation/feasibility study processes. Clarity is also needed for understanding how decisions regarding TI waivers are being made when there are TIE elements still being investigated/evaluated under the site-wide remedial investigation/feasibility study. The Proposed Plan and Record of Decision will need to be very clear, again to avoid the EFRA precluding future remedial actions related to surface water and groundwater conditions that are still under investigation and evaluation through the ongoing site-wide remedial investigation/feasibility study processes. Water Board staff currently see risk regarding this matter given that the EFRA is a final remedial action, not an interim remedial action or removal action, involving surface water and groundwater resources.

On January 14, 2022, the Water Board provided a comment letter regarding the analysis and conclusions for OU-1, the Remedial Action Objectives, and the EFRA components discussed above and as presented in the draft FFS. The Water Board comments are on the pre-publication draft of these documents. A more formal public comment period will occur once the draft has been amended in a manner acceptable to USEPA, and once USEPA publishes a Proposed Plan for public review. Additional information and detail regarding the comments provided in that letter are provided below.

Recommended Alternative Components and Technology Screening

While Atlantic Richfield is under a USEPA order to fulfill the Remedial Investigation/Feasibility Study responsibilities for the Leviathan Mine site, the Water Board is responsible for designing, constructing, operating and maintaining all remedial actions at the site, pursuant to the 2015 Settlement Agreement between the State of California and Atlantic Richfield. As a result, the Water Board is in a unique position when it comes to reviewing and commenting on CERCLA documents related to Leviathan Mine (e.g., EFRA draft FFS and TIE; Proposed Plan, Record of Decision). The Water Board is a responsible party subject to USEPA orders, and must ensure that the State of California's environmental and regulatory interest are being adequately represented. The Water Board must also evaluate what Atlantic Richfield is proposing

for remedial actions through its draft Feasibility Study to ensure that such remedial actions will be protective of human health and the environment, can be constructed, and make operational sense on a long-term basis.

It is under these conditions that Water Board staff has evaluated the Recommended Alternative proposed in the draft FFS and submitted comments with respect to the Recommended Alternative's specific components and also the technology screening that is presented and referenced in the draft FFS. Water Board staff, in general, agrees with several key EFRA objectives (e.g., year-round AMD capture from five primary AMD sources; new centralized treatment facility; access road improvements); however, Water Board staff finds the analysis in the draft FFS is currently insufficient to support restricting the options for achieving those objectives to the specific components currently identified by the Recommended Alternative. Instead, Water Board staff recommends the selection of specific design components intended to meet EFRA objectives during remedial design. During remedial design, more detailed, in-depth geotechnical and other design-related investigation/analysis for treatment sites, AMD storage sites, and sludge management/disposal sites will occur. This investigation/analysis will likely generate information to better identify stable and safe site conditions for existing and new facilities/infrastructure, help ensure that existing and new facilities/infrastructure do not increase risks of environmental damage/harm, and more accurately estimate the project costs associated with ensuring such conditions. This type of information and analysis (further identified below) is critical to making sound final design decisions regarding the specific components of the Recommended Alternative.

Water Board staff is recommending the following be identified as potential components of the remedy subject to further evaluation during remedial design, and that the Proposed Plan and Record of Decision allow for such further evaluation and for flexibility in selecting the specific components of final remedial actions.

1. **New Centralized Treatment Facility Site Selection –** The Recommended Alternative currently identifies a location near Pond 4 and adjacent to Atlantic Richfield's existing high-density sludge (HDS) treatment facility as the preferred location for the new HDS treatment facility. Water Board staff has also discussed the possibility of locating the new HDS treatment facility near Pond 1 and has identified some benefits to this location over the other. Water Board staff recognizes that additional site investigation and analysis is still required before the Pond 1 site can be fully evaluated. However, the potential benefits of locating the new HDS treatment facility at the Pond 1 site justify further evaluation. The Pond 4 site also requires additional information and analysis to support its identification as the preferred site. Required additional information and analysis includes:
    - **Slope stability analysis of the Delta Slide area –** Appendix C of the draft FFS acknowledges "Areas of slope instability in the mine waste slopes adjacent to this

candidate site [Pond 4].” The area referenced in the quotation is the Delta Slide area, and the draft FFS goes on to state, “it is Wood’s understanding that the stability of the slopes will be evaluated and mitigated as necessary at a later date as part of the site-wide remedial actions.” Wood is Wood Environment & Infrastructure Solutions, Inc. who prepared the draft FFS on behalf of Atlantic Richfield. It is Water Board staff’s position that the referenced slope stability analysis be completed prior to selecting the Pond 4 site as a specific component of the Recommended Alternative. The slope stability analysis could identify the need for significant, technically challenging, and potentially costly mitigation measures to ensure stable and safe site conditions for the new treatment facility at the proposed Pond 4 site. Having this information is necessary before making a final decision regarding selection of the Pond 4 site for the new HDS treatment facility.

- **Pond 2N embankment stability/deformation analysis –** The slope stability analysis for the downstream embankment for Pond 2N (Appendix B of draft FFS) shows that the embankment does not satisfy the slope stability criteria for the pseudo-static condition. Atlantic Richfield subsequently conducted a dynamic deformation analysis of the embankment that shows a potential for 16 inches of deformation at the top of the Pond 2N embankment under certain circumstances. The Water Board notes in its comments to USEPA regarding the draft FFS that such deformation creates the potential for AMD to overtop of the Pond 2N liner and seep into the embankment, further reducing slope stability. Understanding the threat such slope instability presents to the Pond 4 site and how to mitigate it is necessary prior to a final decision regarding selection of the Pond 4 site for the new HDS treatment facility.
- **Slope stability analysis of “Pond 4 slope” –** In 2017, the slope to the east/northeast of Pond 4 experienced a rotational slump at its base that (1) forced the primary access road for the upper ponds and the Water Board’s Pond Water Treatment System upward, making the road unusable, and (2) presented a direct threat to the integrity of Pond 4 located on the opposite side of the road from the slope. The Water Board oversaw a temporary repair of the slope and primary access road in coordination with USEPA. Since completing the temporary slope repair, there has been no geotechnical investigation of the “Pond 4 slope”. Given the threat that the relatively small rotational slump presented to Pond 4 and Atlantic Richfield’s HDS treatment system operations, a thorough geotechnical investigation of the entire slope must be completed in order to identify any mitigation measures that would be required to ensure stable and safe site conditions for existing and new facilities. Any necessary mitigation measures have the potential to affect site selection for the new HDS treatment facility, and must be identified and evaluated prior to making a decision regarding selection of the Pond 4 site for the new HDS treatment facility.

The Water Board's comments identify additional factors, some including analyzing threats that existing AMD storage and other existing facilities present to the Pond 4 site, and operational issues such as differences in power requirements associated with the Pond 4 and Pond 1 sites.

Based on information provided in the Water Board's comments to USEPA and presented above, additional analysis is still required prior to making a final decision regarding the future site of the new HDS treatment facility. Such analysis can be and is typically done as part of remedial design and can be incorporated into the final FFS and subsequent CERCLA documents without delaying the EFRA's progress through the CERCLA process. The Recommended Alternative should be revised to identify the Pond 4 *and* Pond 1 sites as potential sites for the new HDS facility and to require additional evaluation prior to making a final decision.

2. **Direct Source Treatment or AMD Pond Storage Prior to Treatment –** The Recommended Alternative identifies only one option for storing AMD captured from the five primary AMD sources prior to treatment: storage in the existing lined evaporation ponds. This is how the Water Board currently stores AMD captured from the Adit and Pit Underdrain, but the approach has a number of drawbacks that are identified below. A potentially more favorable alternative is the direct source treatment strategy, whereby AMD is captured from the five primary AMD sources and conveyed directly to the treatment system. If AMD flows exceed the treatment system capacity, then AMD flows in excess of treatment system capacity, or if emergency storage is needed, then excess flows may be stored in a tank and/or the existing evaporation ponds. The Water Board in its comment letter to USEPA recommends the FFS be revised to include a thorough consideration of the direct source treatment strategy. This alternative strategy has the following advantages.

    - **Reduced treatment volumes and treatment costs –** The existing evaporation ponds are open to the environment and have approximately 12 acres of surface area, which captures and stores the rain and snow that fall directly into the ponds. The rain and snow can significantly add to the volume of AMD that the Water Board must treat. For example, during the record-setting 2017 treatment season, the Water Board treated approximately 26 million gallons of pond water (AMD and direct precipitation), of which approximately 10.8 million gallons came from rain and snow. Staff estimates that it cost approximately $550,800 to treat the volume of pond water that entered the ponds as rain or snow during the 2016-2017 wet-weather season. Additionally, based upon the information provided in the draft FFS, it appears peak combined AMD flow from all five AMD sources would not have exceeded the proposed HDS treatment system's maximum treatment capacity of 250 gallons per minute in 2017, avoiding the need to store any AMD in the ponds under the direct source treatment strategy.
    - **Increased consistency in treatment system influent quality –** Using the ponds to store AMD prior to treatment also affects pond water quality throughout

the year due to the addition of rain and snow (seasonal pond stratification and dilution), evaporation as dry and warm weather conditions persist from late spring into early fall (concentration), and chemical reactions that occur within the ponds. These conditions result in highly variable pond water quality throughout the year, which can also affect treatment system performance and effluent quality. In comparison, the estimation of influent quality of the combined five AMD sources provided in the draft FFS (Appendix F) shows that the influent quality to the treatment plant under the direct source treatment strategy would have remained much more consistent than an influent derived from pond water and that a more consistent influent would have resulted in improved treatment performance.

The information outlined above provides a strong basis for the Water Board's position that it is premature for the FFS to limit the treatment strategy to one that only considers storing AMD in the ponds prior to treatment when the direct source treatment strategy may be possible and provide important benefits. The Water Board requests that the direct source treatment strategy be fully evaluated as part of the Recommended Alternative prior to identifying specific AMD management practices.

3. **Deepening Pond 2S –** The Recommended Alternative includes the specific component of deepening Pond 2S from approximately 5.7 feet deep to approximately 17 feet, creating an additional 8.4 million gallons of storage in Pond 2S. However, additional information and analysis is still required before a final decision is made to include this action as a specific component of the Recommended Alternative. The additional information and analysis needed includes:

   - **Slope stability analysis –** The slope stability analysis in Attachment E of the draft FFS's Appendix B does not evaluate the potential destabilization of the narrow berm between Pond 2S and Pond 2N that could result from deepening Pond 2S. The slope stability analysis also needs to evaluate the stability of the Pond 2N downstream embankment (towards Pond 2S) when Pond 2N is full and Pond 2S is empty, as this would be the likely condition during construction.
   - **Excavated material estimated volume –** Information provided in the draft FFS indicates approximately 45,830 cubic yards of material that is expected to be acid-generating will need to be excavated in order to deepen Pond 2S. It is unclear whether this volume estimate includes an expansion factor to account for the increase in volume that occurs when soil is excavated, which impacts material haul and placement cost estimates. It is also unclear if the volume estimate includes any over-excavation of unsuitable materials below Pond 2S or if the volume estimate accounts for any benching of slide slopes for construction of the embankment.
   - **Excavated material disposal location(s) –** The draft FFS is vague regarding the disposal location(s) for the excavated material from Pond 2S, which is likely

to be hazardous material. The draft FFS states that the material excavated from Pond 2 "would need to be stockpiled elsewhere on the site." Given the quantity of material, and the likelihood that the excavated material will be acid-generating and potentially hazardous, at a minimum a conceptual plan for the final disposal of the material needs to be developed.

- **Decreased AMD storage during construction –** It is reasonable to expect that Pond 2S will not be available for storing AMD while construction activities for deepening Pond 2S are occurring. The draft FFS does not evaluate the increase in risk of discharging untreated AMD to Leviathan Creek that will likely occur as a result of taking Pond 2S out of operation, nor does the draft FFS identify any measures that could mitigate the increase in risk.

The Water Board's comments to USEPA identify the need for the additional information and analysis prior to making a final decision on if deepening Pond 2S should be a specific component of the Recommended Alternative. As with the treatment siting issue, further analysis concerning deepening Pond 2S can be done as part of remedial design, allowing the EFRA to continue to progress through the CERCLA process. This is the pathway forward that the Water Board recommends in its comments to USEPA.

4. **Storage Tank Technology Screening (AMD Storage) –** The draft FFS includes technology screening analysis as well as alternative analysis. The Water Board in its comments to USEPA identified a number of issues regarding the technology screening analysis for storage tanks as an option for AMD storage and concluded that storage tank technology should be retained for further evaluation during remedial design. These issues include:

   - **Analysis based upon single extreme scenario –** The screening technology analysis provided in the draft FFS is based upon the scenario of providing the same storage capacity using tanks as that currently provided by the existing pond system (approximately 15.4 million gallons). Water Board staff believes the use of tanks on a smaller, more strategic scale than evaluated in the draft FFS, such as the used described above for AMD flows that exceed the capacity of the treatment system. Such smaller-scale use of a tank could provide an effective alternative to the AMD pond storage option and could reduce or avoid the disadvantages of AMD pond storage. Storage tanks also create the possibility of reducing the footprint required for AMD storage, which is an important attribute for a site like Leviathan Mine, where usable land space is limited.
   - **Considerations with storage tank technology –** The draft FFS (Table 5-3) identifies a number of conditions that must be met for tanks to be used, including withstanding seismic forces, quality assurance/quality control during construction, tank corrosion, and tank maintenance. The draft FFS implies that addressing such conditions is significantly different or more challenging or more costly than

choosing the AMD pond storage option. However, as noted in its response to the draft FFS, storage tanks would be designed and constructed to withstand seismic forces in compliance with federal, state, and local requirements. In addition, there are (1) corrosion-resistant products to protect tank interiors and exteriors; (2) quality assurance/quality control will be a critical element for construction of the project improvements contemplated by the draft FFS, including tanks, pond liners, embankments, AMD conveyance systems, and the new treatment facility; and (3) tanks are routinely designed and constructed to allow for safe worker access for inspecting and maintaining tank interiors. In short, the conditions identified for the use of tanks are not insurmountable conditions, nor are they of a nature that indicates storage tanks should be eliminated from consideration as a viable AMD storage technology at this time.

Storage tanks, used on a smaller scale than that evaluated by the draft FFS, have the potential to provide a constructible and cost-effective alternative to AMD pond storage, and may provide a means to safely store other fluids as is currently occurring at the site. Given the above information, the Water Board in its comments to USEPA recommends that Table 5-3 in the draft FFS be revised to retain storage tank technology for further consideration during remedial design.

5. **Onsite or Offsite Sludge Disposal –** Currently, the Water Board and Atlantic Richfield transport their treatment sludges offsite to U.S. Ecology's waste disposal site in Beatty, Nevada. Sludge from the existing treatment systems is characterized as a non-RCRA hazardous waste and for purposes of the draft FFS's alternatives analysis, sludge from the new HDS treatment is assumed to be a non-RCRA hazardous waste. The Recommended Alternative proposes onsite disposal of sludge by pumping sludge slurry to a double-lined surface impoundment with a leachate collection and recovery system that enables sludge solids to settle with decant water discharged to Leviathan Creek. The surface impoundment (referred to as sludge repository in the draft FFS) is proposed to be located in the Pit, where the Water Board's pit clarifier (current pond water treatment system sludge dewatering system) and the Pit Underdrain is located. In its comments on the draft FFS, the Water Board identifies a number of issues including state siting criteria and how to mitigate the Pit's slope stability/rockfall conditions that need additional information and/or analysis before they can be fully evaluated and resolved. Additionally, the State of California must determine if it is in its best interest to own and be responsible for operating and maintaining a waste management/disposal facility that may contain hazardous waste in perpetuity. These, and other additional issues enumerated below, must be resolved before a final decision is made regarding onsite or offsite sludge disposal for the EFRA.

   - **Cost analysis –** The basis for the draft FFS's cost estimate regarding annual operation and maintenance costs for the onsite sludge management/disposal alternative is not clearly identified. For example, it does not appear that the cost

estimate takes into consideration closure costs[2], which could be significant and include costs for physical modifications to the surface impoundment as it subsequently becomes managed as a closed landfill, and costs for ongoing facility inspection, leachate monitoring, and potentially leachate treatment in perpetuity.

- **Regulatory requirements –** Surface impoundments and landfills containing hazardous waste are subject to California Code of Regulations, Title 23 and/or 27 requirements. These requirements are prescriptive in nature and address facility siting, design, construction, operation and maintenance, monitoring, and facility closure. The draft FFS does not include the detailed geotechnical and other information required to determine if the proposed surface impoundment can satisfy Title 23 and/or 27 requirements. Further, the sludge characterization or quality for the new treatment facility is unknown, and waste characterization plays a key role in determining what siting and design criteria and construction standards apply to the proposed onsite sludge management/disposal facility.
- **Unknown impact on Pit Underdrain –** The proposed onsite surface impoundment for sludge disposal is to be located directly over the Pit Underdrain, one of the five primary AMD sources to be addressed by the EFRA. The Pit Underdrain system is an underground AMD collection system and is relatively shallow in depth. The draft FFS does not evaluate the Pit Underdrain's vulnerability to potential adverse impacts from the surface impoundment's dam and the increasing weight associated with discharging a sludge slurry for decades or longer.
- **Sustainability/Environmental Footprint Analysis –** The sustainability/environmental footprint analysis of the draft FFS's offsite sludge disposal alternative assumes that diesel fuel powered trucks would be used to transport sludge to Beatty, Nevada. Given the State of California's efforts to reduce greenhouse gas releases, including allowing sales of only zero-emission vehicles by 2035, the sustainability/environmental footprint analysis should include an analysis that uses zero-emission trucks to transport sludge.

Many critical data and information gaps need to be filled to determine if onsite sludge disposal should be a specific component of the Recommended Action. Some of the needed information could be obtained during remedial design (e.g., site-specific geotechnical information) while other information may not become available until the new treatment facility has been operational for some time. Additionally, the

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[2] While the sludge will initially be pumped to a surface impoundment subject to California Code of Regulations, Title 23 and/or 27 requirements for surface impoundments, once the surface impoundment has reached its capacity, it will ultimately be closed as a landfill and be subject to California Code of Regulations requirements for a closed landfill.

State of California is still evaluating a number of technical, legal, and policy issues associated with an onsite waste disposal facility that could contain hazardous waste. As a result, the Water Board in its draft FFS comments to USEPA recommends against identifying the onsite sludge disposal alternative as a specific component of the Recommended Action.

6. **Reverse Osmosis and Ion-Exchange Technology Screening –** The draft FFS evaluates reverse osmosis (RO) and ion-exchange (IX) treatment technologies for purposes of further reducing metals concentrations following HDS treatment. However, the draft FFS evaluates only one scenario; treating all of the HDS treatment system's effluent. The draft FFS does not consider the option of treating only a portion of the HDS treatment system's effluent and evaluating the potential benefits and costs of this option. Additionally, the Water Board in its draft FFS comments to USEPA identified a number of issues regarding the draft FFS's influent quality and effluent quality analysis that could have an effect on the analysis of the benefits and costs associated with limited RO or IX treatment. The following justifies retaining these two treatment technologies for further evaluation during remedial design.

    - **Treating a portion of HDS effluent –** A treatment strategy where only a portion of HDS treatment system effluent is diverted for RO or IX treatment is expected to result in significant reductions in RO or IX facility footprint, waste generation, and capital and operational costs compared to those of RO or IX facilities designed to treat all of the HDS treatment system's effluent. Water Board staff also expect that the footprint of RO or IX facilities could be minimized with the use of tanks instead of ponds for flow equalization and waste containment.
    - **Two-stage RO system -** Two-stage RO treatment should also be evaluated, given that it could reduce the RO reject volume by 80%-90%, significantly reducing truck traffic compared a one-stage RO system. Water Board staff recognizes that there are potential challenges with two-stage RO systems, such as scaling of membranes and other RO components. However, Water Board staff is aware that a multi-media filter was tested as part of the 2020 HDS Treatability Study and requests additional consideration of the potential use of a multi-media filter or other means to mitigate potential issues created by two-stage RO reject. Additionally, the expected waste classification of the RO reject from a two-stage RO system should also be identified as part of evaluating two-stage RO technology. This is the type of information needed for a thorough evaluation of benefits and costs. Disposal costs currently involve transportation of RO reject to facilities in Texas and Ohio, in addition to Beatty, Nevada.

    Treating a portion of the HDS effluent and using tanks instead of ponds create potential opportunities to further reduce metals concentrations, which in turn provides increased human health protection and water quality improvements at reduced costs compared to RO or IX treatment of all HDS effluent. The potential for

treating a portion of HDS effluent to be a viable treatment strategy indicates these two treatment technologies should be retained for further evaluation during remedial design.

7. **Onsite Power Evaluation –** The draft FFS recommends bringing power sourced through Liberty Utilities as the permanent power supply for the Leviathan Mine site. While not directly stated, it appears that emergency power would be supplied by diesel generators. Water Board staff agrees with this approach, in general, but strongly recommends that the Recommended Alternative also include the ability to incorporate limited-scale solar power for some of the proposed improvements (e.g., administrative buildings, some treatment components). Using solar to some extent would bring the power supply for the mine site into closer alignment with California's goals to reduce greenhouse gas emissions and could reduce power costs over time. There also appears to be adequate land area to locate solar facilities at the site capable of providing power to some, if not all of EFRA-related facilities.

Applicable or Relevant and Appropriate Requirements

In June 2019, the Water Board submitted the State of California's list of potential applicable or relevant and appropriate requirements (ARARs) for the proposed EFRA to the USEPA, as requested. The list of ARARs was compiled and submitted following consultation with other state agencies including Department of Fish and Wildlife, Department of Resources Recycling and Recovery, Department of Toxic Substance Control, Office of Environmental Health Hazard Assessment, Department of Water Resources-Division of Safety of Dams, and the Great Basin Unified Air Pollution Control District. The list includes a combination of requirements based upon state laws, policies, and regulations. Examples of ARARs regarding water quality include, but are not limited to:

- Present and potential beneficial uses of surface waters and groundwaters (Water Quality Control Plan for the Lahontan Region);
- Numerical and narrative water quality objectives for surface waters and groundwaters (Water Quality Control Plan for the Lahontan Region);
- Waste classification criteria and surface impoundment and landfill siting criteria (Title 23 and Title 27, California Code of Regulations);
- Requirements to maintain high quality waters and the criteria that must be satisfied in order to degrade high quality waters (State Water Board Resolution No. 68-16 (Anti-degradation Policy));
- Requirements for investigation and cleanup and abatement of waste discharges, including attainment of background quality or the best quality that can be attained if background quality cannot be restored (State Water Board Resolution No. 92-49, as amended); and

- Requirements regarding a standardized approach to permitting the discharge of toxic pollutants to inland surface waters, enclosed bays, and estuaries in California that are subject to regulation under the Porter-Cologne Water Quality Control Act (Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, 2005).

Atlantic Richfield has put forth its list of potential ARARs in the draft FFS and has included a small portion of those the Water Board provided USEPA. Some of the State's potential ARARs Atlantic Richfield failed to identify include, but are not limited to, the numerical water quality objectives that apply to Leviathan Creek and Aspen Creek, and the Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, 2005. In comments on the draft FFS, the Water Board disagrees with and expresses concerns with the limited scope of potential ARARs provided in the draft FFS.

The ARARs issue will require additional analysis and discussion. It is Water Board staff's understanding that USEPA review the potential ARARs put forth to date, and evaluate them in consultation with Water Board staff, Atlantic Richfield, and others as part of the ongoing CERCLA process. Ultimately, the ARARs will be identified in the Record of Decision for the EFRA. Water Board staff is looking forward to future consultation with USEPA on this matter.

Groundwater

As stated above, Atlantic Richfield's identification of the five primary AMD sources as the remedial action for addressing mining-related groundwater impacts has complicated and slowed progress towards a Record of Decision for the EFRA. The complications are due, in part, to characterizing the nature of and delineating the extent of groundwater impacts associated with mining activities in a hydrogeologically complex area significantly altered by mining activities with no pre-mining groundwater data/information. In this situation, it is difficult to satisfy applicable regulatory requirements (e.g., delineating the extent of contaminated or mine-influenced groundwater; evaluating human health and environmental risks; limiting the area for technical impracticability waivers or containment zones) tied to the groundwater-related proposals (e.g., technical impracticability waiver of all groundwater-related ARARs in the Leviathan Creek watershed) presented in the draft FFS. The Water Board in its comments to USEPA suggests that the EFRA continue proceeding through the CERCLA process towards a Record of Decision, while the Water Board, USEPA, and Atlantic Richfield continue to work on how the applicable regulatory requirements may be satisfied.

A significant portion of the draft FFS's analysis and conclusions regarding groundwater is based upon an evaluation of groundwater conditions at and downgradient of the mine site performed by S.S. Papadopulos & Associates, Inc. (SSPA) in 2020 on behalf of

Atlantic Richfield. The results of SSPA's evaluation is provided in *Evaluation of Groundwater Conditions, Leviathan Mine, Alpine County, California* (SSPA Groundwater Report) (SSPA 2021). The SSPA Groundwater Report provides analysis and a number of conclusions regarding groundwater movement, assessing the amount and fate of groundwater moving through the mine site, and the extent of mining-related impacts upon groundwater. Water Board staff and its consultant, Desert Research Institute, have had the opportunity with USEPA to informally provide comments upon two drafts of the SSPA Groundwater Report. Some of Water Board staff's comments have been addressed, but significant issues remain with the analysis and conclusions provided in the SSPA Groundwater Report cited in the draft FFS. Following are some of the more critical elements of the draft FFS's groundwater analysis that Water Board staff believes must still be addressed.

Water Balance – The water balance analysis provides a methodology for identifying and quantifying groundwater system inputs (e.g., infiltration of precipitation) and outputs (e.g., the five primary AMD sources, surface waters, the bedrock groundwater zone) when evaluating how groundwater moves into the influence of the mine site and beyond. Water balance models typically form the foundation for developing an understanding or conceptual site model of groundwater movement through and beyond a site. The water balance analysis provided in the SSPA Groundwater Report relies, in part, upon onsite precipitation over a six-year period as part of the analysis for determining how much groundwater is coming into the Leviathan Mine groundwater system. Water Board staff has developed and shared an alternative water balance analysis that, in part, relies upon 20-plus years of precipitation from a nearby Snotel system monitoring facility and 20-plus years of Adit and Pit Underdrain flow data and pond water level data. The Water Board analysis identifies significantly more groundwater coming into the influence of the mine site that the SSPA analysis does, calling into question the relative volumes or percentages of groundwater that are (1) captured through the five primary AMD sources, (2) discharged to Leviathan Creek and other surface waters, and (3) migrate to the underlying bedrock aquifer.

Delineating Extent of Groundwater Impacts – Atlantic Richfield has performed substantial groundwater monitoring throughout and surrounding the mine site, especially of the shallow or unconsolidated groundwater zone, but not as much for the bedrock groundwater zone. In spite of Atlantic Richfield's groundwater monitoring system, Water Board staff and its consultant, Desert Research Institute, have identified areas in the shallow groundwater zone and other areas of the bedrock groundwater zone where the extent of mining-related groundwater impacts is still in question. The draft FFS also relies upon an analysis for defining and delineating mine-influenced groundwater that is based upon sulfate concentrations and pH levels, rather than an evaluation of concentrations of all metals addressed by the EFRA. Water Board staff are open to considering this approach; however, the FFS needs to provide technical support that demonstrates using sulfate and pH as surrogates for the select metals accurately reflects the extent of mine-influence groundwater. For example, providing a

figure that depicts the concentrations of the select metals and with sulfate concentrations and pH levels. Additionally, Water Board staff and its consultant have questioned the validity of using data from some of the monitoring wells SSPA included in its development of the sulfate concentration to define the extent of mine-influenced groundwater. There are also issues with well construction and well location that form the basis of Water Board staff's request for further review of Atlantic Richfield's methodology for defining and delineating mine-influenced groundwater.

The groundwater analysis elements discussed above play a critical role in understanding how groundwater moves through and is influenced by the mine site. An accurate understanding of such conditions is vital as it forms the foundation upon which decisions are made regarding how to address groundwater impacts and assessing the risks of impacted groundwater on human health and the environment. Water Board staff believes there is room for significant improvement in the analysis and discussion of the basis for the analysis that is used to support the draft FFS's conclusions concerning groundwater or to develop new conclusions. Water Board staff has identified where the improvement is needed in order to produce a technically and legally defensible Record of Decision for the EFRA. Water Board staff have also identified a pathway forward that should not delay the EFRA's progress through the CERCLA process while the Water Board, USEPA, and Atlantic Richfield work to resolve these issues.

Proposed Discharge Evaluation

Discharges to waters of the state are required to comply with the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, State Implementation Policy (SIP). The SIP applies to discharges of toxic pollutants into the inland surface waters, enclosed bays, and estuaries of California subject to regulation under the State's Porter-Cologne Water Quality Control Act and the federal Clean Water Act. The SIP establishes a standardized approach for permitting discharges of toxic pollutants to non-ocean surface waters in a manner that promotes statewide consistency and requires evaluation of impacts resulting from discharges to surface waters. The SIP has been approved by USEPA and follows USEPA guidelines for discharges to surface water. The Water Board identified the SIP as a substantive state law requirement, and therefore an ARAR.

The draft FFS's evaluation of the elements described above does not follow the SIP. The draft FFS also does not provide an explanation for how and why Atlantic Richfield selected the approach it did over that of the SIP in determining potential impacts to surface water, calculating effluent concentrations, providing downstream concentration estimates based on different effluent flow conditions determining assimilative capacity, as well as evaluating anti-degradation and selecting background concentrations.

Additionally, the State's Anti-Degradation Policy notes that the existing high quality of water will be maintained until it has been demonstrated that any change will be consistent with the maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than prescribed in State Board and Regional Board policies. The State's Anti-Degradation Policy also requires that for any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (1) a pollution or nuisance will not occur; and (2) the highest water quality consistent with maximum benefit to the people of the State will be maintained. No anti-degradation or assimilative analyses have been submitted.

Risk Reduction

A risk reduction evaluation was completed as part of the draft FFS comparing the no action alternative to the recommended alternative. The no action alternative, however, is represented as if there is no capture or treatment of AMD, no operation or maintenance of the existing remediation infrastructure, and no efforts to control the release of AMD metals to surface waters. The result is a significantly larger estimation of benefits compared to the benefits that would be realized if the baseline condition included ongoing AMD capture and treatment activities. In its comments to USEPA, the Water Board recommended that the no action alternative analysis should be based upon current conditions regarding AMD capture and treatment, rather than conditions that have not occurred since the mid-1980s. At a minimum, the FFS should include a discussion regarding risk reduction that takes into consideration ongoing AMD capture and treatment, so that the interested stakeholders and general public has a better understanding of the EFRA's anticipated benefits compared to current conditions.

Section 2: Technical Impracticability Evaluation

Technical Impracticability Evaluation and Waiver Overview

A Technical Impracticability (TI) Waiver is a mechanism within the CERCLA process for seeking waiver of specific ARARs, consistent with CERCLA Section 121 (b) and the National Contingency Plan (NCP) (40 CFR 300.430(f)(1)(ii)(C)(3)). Through analysis of site data and demonstration of the technical impracticability of achieving certain ARARs (for example, maximum contaminant levels [MCLs] or other federal or state standards), a waiver may be appropriate.

Atlantic Richfield submitted a Technical Impracticability Evaluation (TIE) for the EFRA on September 30, 2021. For groundwater, Atlantic Richfield seeks a TI waiver for all ARARs identified in the OU-1 FFS for the entire area of mine-influenced groundwater at or near the mine and the remainder of the Leviathan Creek watershed, both upgradient

and downgradient of the mine-disturbed areas. Atlantic Richfield also seeks numerous TI waivers for applicable surface water standards for the metals aluminum, arsenic, beryllium, manganese, mercury, and thallium, as well as to waive application of State Water Board Resolution No. 92-49 (Resolution 92-49) from the mine site to a location several miles away in the state of Nevada.

Analysis of Technical Impracticability Evaluation and Waiver Requests

With respect to groundwater, the Technical Impracticability Evaluation (TI) does not adequately establish background conditions, nor does it contain sufficient information or analysis to define the appropriate geographic scope of a TI waiver. The conceptual site model underlying the analysis is not sufficiently robust to establish such scope. With respect to surface water, AR erroneously seeks a technical impracticability waiver of Resolution 92-49 with no valid justification, declines to follow the proper sequencing procedures for a TI waiver, and seeks to waive standards for many more metals than is warranted based on available data. Resolution 92-49 establishes the requirements for investigation and cleanup and abatement of waste discharges, including attainment of background quality or the best quality that can be attained if background quality cannot be restored. Prioritizing attainment of background quality is a critical element of Resolution 92-49. So is the Containment Zone Policy portion of Resolution 92-49, as amended, which establishes the criteria under which a containment zone (i.e., specific portions of groundwater-bearing units where water quality objectives cannot be reasonably achieved) can be established, containment zone requirements, and the process for establishing a containment zone.

The Water Board in its comments to USEPA notes that the Water Board may be willing to support consideration of a more limited TI waiver or waivers and is open to the idea of properly limited TI waivers where proper source control, site delineation, and overall remedial sequencing are observed. In its comments, the Water Board noted that USEPA generally discourages the use of “front-end” TI waivers – waivers sought prior to remedy implementation – but that they may be suitable in rare situations where the remediating party has followed an appropriately phased approach to remedy implementation and seeks a TI waiver only when other measures have failed during the remedial sequencing process. For example, the TI included examples of sites where front-end TI waivers were used along with additional investigations to provide needed information to either eliminate the need for the waiver or provide further justification for it. At the Ely Copper Mine, in Vermont, significant deposits of unmined ore remain in the ground along with naturally occurring minerals capable of leaching into the groundwater indefinitely. USEPA approved a front-end TI waiver for groundwater in the underground mine workings only. A key component of the waiver was a commitment to conduct a groundwater pre-design investigation (PDI) to determine the extent of the contamination and the necessary extent of the use restrictions. The TI waiver was limited in geographic extent to the mine workings and the use restrictions were limited to the mine workings plus the areas that would draw water from them. Long-term monitoring and

site inspections were put in place. Recognizing that insufficient data existed to determine the appropriate scope of the waiver and the use restriction, the selected remedy includes the PDI to "further develop the [CSM] from Underground Workings and to delineate the extent of the groundwater use restriction area . . . The types of activities that may be performed include: additional bedrock outcrop evaluations; surface geophysical investigation; installation of additional bedrock monitoring wells; groundwater sampling; and 3-D Digital Model and Groundwater Modeling."

The Water Board in its comments to USEPA identifies multiple deficiencies in the TI and draft FFS's groundwater characterization and explains how such deficiencies mean that a TI waiver is not appropriate for the site at this time. However, as discussed above, the Water Board is open to the concept of using some sort of contingent waiver with requirements to collect additional information.

Currently, evaluation of the need for a TI waiver for surface water standards is simply not feasible for multiple reasons. First, the performance of the proposed HDS treatment system is unknown with respect to treating AMD from all five primary AMD sources combined. Atlantic Richfield has estimated influent quality for several influent flow regimes and estimated the resulting effluent quality. However, these are estimates and the new HDS treatment system's actual performance is unknown. Following the date the Water Board's comments were due, Atlantic Richfield released its HDS Treatability Study Report that provides information regarding HDS treatment technology's ability to treat combined flows from all five primary AMD sources (treatment of consistent influent quality was evaluated for several treatment system configurations on a pilot scale in 2020) and the effluent quality that was produced for each configuration. Water Board staff is still evaluating the report's analysis and conclusions, and more will be known once this information is digested and after the system is operational.

Second, with respect to TI waivers for metals, the Water Board believes the TIE's analysis was not well supported. For example, initial review of aluminum concentrations in Leviathan Creek upstream of the mine site indicates that HDS treatment system effluent aluminum concentrations may be at or below aluminum concentrations upstream of the mine site. If true, then a TI waiver would not be justified for aluminum.

Third, there are other media that are being evaluated as part of the site-wide remedial investigation/feasibility study, the results of which could affect compliance with ARARs. These results are not in hand to inform the analysis in the EFRA FFS or the TIE. One example is creek sediments in the Beaver Pond area of Leviathan Creek, where sediments containing acid-generating mine waste have the ability to lower pH levels within the creek and threaten to adversely affect water quality in this area and downstream.

Given all of these unknowns, the Water Board in its comments to USEPA recommends postponing any determination about waivers of ARARs for surface water standards until

after the new HDS treatment system is built and has been operating, further analysis of metal concentrations upstream may be conducted, and the impact of other media in the area can be analyzed to better inform the overall analysis.

Section 3: Summary

The EFRA has the potential to improve surface water quality in Leviathan Creek and downstream surface waters. However, the draft FFS and TIE have significant issues that must be addressed in order for the Water Board to support them. Fortunately, at this time, there appears to be a path forward that would allow the EFRA to continue through the CERCLA process while the Water Board, USEPA, and Atlantic Richfield work towards resolution of the problems identified. Water Board staff is committed to working with Atlantic Richfield and USEPA to resolve the matters discussed in this report.

In addition to working with Atlantic Richfield and USEPA, Water Board staff will also be briefing and coordinating with State Water Board, CalEPA, and Department of Finance Managers and Executives regarding issues such as ARARs, onsite sludge disposal, and funding for remedial design, construction, and operation and maintenance. Working and coordinating with interested stakeholders such as the Washoe Tribe of Nevada and California, the United States Forest Service, the California Department of Fish and Game, and others is also on the list of ongoing and future actions for Water Board staff. Staff will also be working with the Department of General Services in preparation of developing and managing contracts that will be needed to do complete design and construction activities, and conduct system operations and site/facility maintenance. A lot of activity to come and in addition to ensuring that the Water Board continues to do its part in restoring water quality and the beneficial uses of the surface waters and groundwaters at and surrounding the mine site.

Figure 1: Leviathan Mine Site Map

ENCLOSURE 3

Lahontan Regional Water Quality Control Board

January 14, 2022

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Comments on Atlantic Richfield Company's Focused Feasibility Study for OU-1 Mine-Influenced Groundwater and Metals in Surface Water, Leviathan Mine Site, Alpine County, California

Thank you for the opportunity to comment on Atlantic Richfield Company's (AR) August 6, 2021, *Focused Feasibility Study for OU-1 Mine-Influenced Groundwater and Metals in Surface Water* for the Leviathan Mine Site. The California Regional Water Quality Control Board, Lahontan Region (Water Board) staff have the following comments, offered to support the development of a mutually acceptable focused Feasibility Study (FFS), Proposed Plan and Record of Decision for the implementation of an Early Final Remedial Action (EFRA) for OU-1. To that end, Water Board staff have, and will continue to work with the United States Environmental Protection Agency (USEPA) and AR to resolve remaining issues. Water Board staff look forward to fulfilling our role as the lead support agency as defined in CERCLA.

Components to the Recommended Alternative and Technology Screening

Although Water Board staff agree with several major components of the Recommended Alternative, staff finds that the FFS falls short in providing sufficient evidence to conclude that the following proposed actions should be identified as specific components to the Recommended Alternative:

- Diverting all Acid Mine Drainage (AMD) to the storage ponds prior to treatment (rather than direct treatment of sources).
- Deepening Pond 2S.
- Locating the HDS treatment plant at Pond 4.

- Disposing sludge in an on-site surface impoundment/landfill (rather than off-site disposal).

More detailed discussion about the above-listed actions and their consideration in the FFS are provided in the following comments. Unless sufficient data and information is provided for review and comment by the Water Board, Water Board staff request that USEPA identify these proposed components as potential options for the remedy, to be further evaluated during remedial design, and that the Proposed Plan or selected remedy not include these specific components as part of the Recommended Alternative.

Water Board staff has also identified issues with the analysis provided in the FFS to screen out technologies from future consideration. In particular, Water Board staff finds the elimination of Storage Tanks, Reverse Osmosis and Ion Exchange from future consideration to be premature. Until such time that sufficient evidence is provided to justify screening out these technologies, Water Board staff request that these technologies be retained for further consideration during remedial design for the EFRA for OU-1.

Groundwater

As AR's consultant, S.S. Papadopulos and Associates' (SSPA) submitted their January 11, 2021 *Evaluation of Groundwater Conditions, Leviathan Mine, Alpine County, California*, to USEPA. Water Board staff worked with our consultant, Desert Research Institute (DRI), to provide an independent review of SSPA's report. DRI's detailed comments were provided to USEPA and AR on February 25, 2021 and are included as Attachment B to this letter. No response has been received and no revisions were made to SSPA's report to respond to DRI's comments. Water Board staff look forward to working with USEPA and AR to resolve issues brought up in DRI's comments and to ensure the EFRA satisfies the State of California's regulatory requirements for cleanups.

Applicable or Relevant and Appropriate Requirements (ARARs)

Water Board staff provided a comprehensive list of ARARs to USEPA in 2019 and we look forward to a review and response to that submittal. Certain ARARs that are particularly critical to compliance with State of California cleanups and have not been applied in this FFS. These ARARs include, but are not limited to:

- The Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, State Implementation Policy (SIP), applies to discharges of toxic pollutants into the inland surface waters, enclosed bays, and estuaries of California subject to regulation under the State's Porter-Cologne Water Quality Control Act and the federal Clean Water Act. The SIP establishes a standardized approach for permitting discharges of toxic pollutants to non-ocean surface waters in a manner that promotes statewide consistency. This standardized approach requires evaluation of impacts resulting from discharges to surface waters. The surface water evaluation in the FFS is substantially incomplete

with respect to determining potential impacts to surface water, calculating effluent limits, providing mixing zone calculations, determining assimilative capacity, as well as evaluating anti-degradation and selecting background concentrations. The SIP has been approved by USEPA and follows USEPA guidelines for discharges to surface water.

- State Board Resolution 68-16 Maintaining High Quality Water evaluation of anti-degradation and assimilative capacity for Leviathan Creek following procedures outlined in the SIP.

- State Board Resolution 92-49 Policies and Procedures for Investigations and Cleanup and Abatement for Discharges Under Water Code 13304.

- Water Quality Control Plan for the Lahontan Region (Basin Plan) including water quality objectives for Leviathan Creek and implementation of Basin Plan requirements for discharges to surface water and cleanups.

- State siting criteria for Landfills, CCR Title 23 and/or 27.

Landfill

Water Board staff have identified a number of issues related to siting a landfill at Leviathan mine and meeting state siting criteria, primarily relating to site stability issues that are raised but not resolved by the FFS. In addition, the state of California is the owner of record for the mine and the best interest of the state must be evaluated with respect to owning and operating a hazardous waste or other landfill at the mine site. Consultations with upper management, legal, Water Board, State Board and CalEPA are underway to determine the state response to this proposal.

Items Referenced in the FFS but not Provided

Water Board staff were unable to complete our evaluation of certain components of the FFS without the submittal of the 2020 HDS pilot study report, we request the submittal of this report from AR. Additionally, all assumptions and input parameters used in the environmental footprint evaluation for the two sludge disposal alternatives are needed for an appropriate evaluation. Please note there may be additional items that have not been provided identified in Attachment A to this letter.

Conclusion

Water Board staff are supportive of moving forward with year-round capture and treatment of the five identified acid mine drainage sources while working to resolve the remaining issues. In order to keep this effort moving forward in an expeditious manner, we would like to discuss separating out areas that are ready for the EFRA with certain aspects being left to remedial design, and allowing areas that require substantial revisions and additional evaluations (e.g. surface water and groundwater) to be completed with the site-wide remedy. Regardless, Water Board staff remain committed in continuing to work with USEPA, AR and other stakeholders in an effort to resolve the

comments in Attachment A to this letter and of other stakeholders. Please feel free to contact me or my staff with any questions regarding this submittal and we look forward to working with you.

Sincerely,

MICHAEL R. PLAZIAK, PG
Executive Officer
California Regional Water Quality Control Board – Lahontan Region

Attachments:

Attachment A: Water Board Staff Comments Regarding AR's FFS for OU-1

Attachment B: DRI's May 12, 2021 Comments Regarding SSPA's Evaluation of Groundwater Conditions

Attachment C: Office of Environmental Health Hazard Assessment (OEHHA) Review of Focused Feasibility Study for OU-1 Mine-Influenced Groundwater and Metals in Surface Water, Leviathan Mine Site, Alpine County, California, August 6, 2021

cc: Elizabeth Adams/United States Environmental Protection Agency, Region IX
Joshua Wirtschafter/United States Environmental Protection Agency, Region IX
Greg Reller/Burleson Consulting, Inc.
Cory Koger/United States Army Corps of Engineers
Brian Johnson/Atlantic Richfield Company
Marc Lombardi/Wood Environmental & Infrastructure Solutions, Inc.
Elizabeth Temkin/Davis Graham & Stubbs
Chairman Serrell Smokey/Washoe Tribe of Nevada and California
Steve Hampton/California Department of Fish and Wildlife
David Friedman/Nevada Division of Environmental Protection
David Risely/United States Forest Service, Humboldt-Toiyabe National Forest
David Coupe/State Water Resources Control Board, Office of Chief Counsel
Thomas Bloomfield/Kaplan Kirsch & Rockwell, LLP

Attachment A

Water Board Staff Comments Regarding
Atlantic Richfield Company's (AR)
Focused Feasibility Study (FFS) for OU-1

Components to the Recommended Alternative and Technology Screening

1) Diverting all Acid Mine Drainage (AMD) to the storage ponds prior to treatment: Appendix E (High Density Sludge Plant Conceptual Design) to the FFS for the Early Final Remedial Action (EFRA) for OU-1 outlines AR's proposed strategy for treating AMD. That strategy consists of routing AMD from the five AMD sources addressed by the EFRA (consisting of the Adit, Pit Under Drain, Channel Under Drain, Delta Seep, and Aspen Seep) to the pond system. From the pond system, the AMD, now mixed with water from rain/snow that lands on the pond surfaces, is eventually routed to a High-Density Sludge (HDS) treatment plant for metals removal. This strategy is very similar to the strategy currently used by the Water Board for the treatment of AMD from three storage ponds at Leviathan Mine. The three storage ponds contain AMD from the Adit and the Pit Under Drain combined with rain/snow that lands on the pond surfaces. Although this strategy has been effective for the Water Board, it does have drawbacks, including the following:

    a) Treating pond water results in the treatment of millions of gallons of water from rain and snow: A significant portion of the fluids held in the storage ponds is from rain and snow that lands directly on the pond surfaces. The pond surfaces cover an approximate area of 12 acres. Water Board staff estimates that in 2017, the Water Board treated approximately 26 million gallons of pond water which included approximately 10.8 million gallons of water from rain/snow. Based on the contract pricing set forth in the Water Board's current contract for the treatment of pond water, Water Board staff estimates that the cost, just to treat the water that entered the ponds as rain/snow in 2017, came to approximately $550,800.

    b) When AMD is stored in ponds, it is impacted by the addition of water from rain and snow, evaporation of water and other chemical interactions. The resulting impacts to pond water quality are not fully understood but the resulting variability in pond water chemistry is documented in AR's Final Report for their 2017 Interim Combined Acid Drainage Treatability Investigation Full-Scale Demonstration project. The FFS does not address the likelihood that influent drawn from the ponds will differ in quality from an influent consisting of combined AMD source water (AMD collected near the location where it seeps out of the ground). It appears that AR has assumed that the quality of pond water (impacted by dilution, evaporation, and other chemical reactions) will match the quality of AMD source water. This assumption is neither explained nor evaluated in the FFS.

The issues resulting from the treatment of pond water, as described above, are expected to persist under the HDS treatment strategy presented in the FFS.

The selection of possible treatment strategies should include careful consideration of potential water/AMD management practices that could reduce the amount of water from rain and snow that needs to be treated, reduce the volume of AMD that needs to be stored, and provide an influent quality that is more consistent with AMD source water. The analysis of alternatives set forth in the FFS falls short in its consideration of such water/AMD management practices. As mentioned above, the FFS proposes one treatment strategy—route the AMD from the five sources to the ponds where it will mix with water from rain and snow, and then treat it all. The FFS presents a very brief discussion related to the possible management of water from rain and snow in the ponds by periodically draining water out to create storage volume for AMD, but this proposed management strategy is not developed sufficiently in the FFS to determine whether it is feasible.

Water Board staff recommend revising the FFS to include thorough consideration of an additional alternative treatment strategy wherein AMD from the five sources would be routed directly to the HDS treatment plant for treatment and subsequent discharge to Leviathan Creek. The storage ponds would be maintained as a contingency for lengthy treatment shutdowns and high-water years. Under this strategy, AMD would only be routed to the storage ponds when the inflow of AMD to the treatment plant exceeds the maximum treatment capacity of the proposed HDS treatment plant (currently proposed at 250 gallons/minute).

Under this strategy, in the event that AMD needs to be diverted to storage, initial storage could be provided in storage tanks (rather than mixing it with rain and snow in a pond). If the inflow of AMD exceeds the initial tank storage capacity, the AMD could then be diverted to the storage ponds. The AMD held in the storage tanks and in the storage ponds, could be held until additional treatment capacity becomes available in the HDS treatment plant. Availability of additional treatment capacity is expected to coincide with a reduction in the combined flow rate of AMD from the five sources which typically occurs in the weeks following annual peak flow.

Based on review of the AMD flow data for the 2017 water year (2017 produced the highest recorded value for accumulated precipitation at the NRCS Monitor Pass Snotel Station) and identified by AR as the Peak Year (99th percentile year), the combined inflow for the five AMD sources approached, but did not exceed, 250 gallons per minute. This fact indicates that the strategy wherein the AMD from the five sources is routed directly to the treatment plant could have avoided the need to divert any AMD to storage ponds and the need to treat any water from rain/snow that landed on the ponds, thus reducing the volume that needed to be treated in 2017 by approximately 10.8 million gallons. In addition, based on the estimation of influent quality provided in the FFS (Appendix F), it is expected that the influent quality to the treatment plant under this treatment strategy would have remained much more consistent than an influent derived from pond water and that a more consistent influent would have resulted in improved treatment performance.

Until such time that the FFS includes thorough consideration of treatment strategies that incorporate water/AMD management practices that could reduce the amount of water from rain and snow that needs to be treated, reduce the amount of AMD that needs to be stored, and provide an influent to the treatment plant that is more consistent with source water chemistry, Water Board staff recommend against identifying the single treatment strategy set forth in the FFS and, in particular, the routing of AMD to the ponds and the storage of AMD in the ponds prior to treatment, as specific components to be included in the Recommended Alternative. Rather, the FFS should identify multiple options, to be considered during remedial design.

Additionally, it should be noted in the FFS that any ponds that remain in service as part of the EFRA for OU-1 will likely require significant modifications to accommodate proposed improvements, including removal and disposal of existing liner cover materials, removal and replacement of existing liners, upgrades to bring the ponds into compliance with current standards, and modification of existing AMD conveyance piping. Therefore, the FFS should be revised to include analysis of the costs associated with these improvements for Alternatives AD-2, AD-3, and AD-4.

2) Deepening Pond 2S: As described in Appendix B (Preliminary Design Brief, Ponds 1 through 4 Storage Alternatives), the Recommended Alternative (Alternative AD-4) would require an increase of approximately 8.4 million gallons in the storage capacity provided in Pond 2S. This increase in capacity would be achieved by deepening Pond 2S, from approximately 5.7 feet to approximately 17 feet (according to numbers provided in Attachment E to Appendix B, Table E-1). Water Board staff have identified data and information that is needed to support the proposed deepening of Pond 2S as a component to the Recommended Alternative:

   a) The berm between Pond 2S and 2N is narrow, which creates stability concerns for deepening Pond 2S, yet the slope stability evaluation provided by Attachment E to Appendix B does not evaluate the potential destabilization of the berm between Pond 2S and 2N, nor does Attachment E include cross sections through the deepened Pond 2S. Slope stability analyses for the proposed deepening of Pond 2S should include evaluation of the Pond 2N downstream embankment (towards Pond 2S) with Pond 2N full and Pond 2S empty (as this would be a likely condition during construction). An evaluation of the potential impacts to the stability of the berm between Pond 2S and 2N, including the information mentioned above, needs to be completed prior to selecting the proposed action as a specific component to the Recommended Alternative.

   b) AR estimates the volume of material that would need to be excavated from below Pond 2S to accommodate the proposed deepening of Pond 2S would total approximately 45,830 cubic yards. This material is expected to be acid generating. Based on the information provided, it is unclear whether the reported volume is the in-place volume or whether the estimate includes an expansion factor to represent the increase in volume that occurs when soil is excavated; this is important for purposes of estimating costs for the required haul and placement of excavated materials. Further, it is unclear whether the estimated volume of

excavated materials includes over-excavation to remove unsuitable materials below the impoundment and benching of side slopes for construction of the embankment. This information needs to be provided and evaluated prior to selecting the proposed action as a specific component to the Recommended Alternative.

c) Regarding the proposed disposal of an estimated the 45,830 cubic yards of potentially hazardous materials to be excavated from beneath Pond 2S, the FFS simply concludes that the waste removed from beneath Pond 2S "would need to be stockpiled elsewhere on the site." At a minimum, a conceptual plan for final disposal of the materials to be removed from beneath Pond 2S needs to be developed and evaluated before selecting the proposed action (deepening of Pond 2S) as a specific component to the Recommended Alternative.

d) Water Board staff anticipate that Pond 2S would not be available for the storage of AMD while construction efforts associated with the deepening of Pond 2S are underway. The FFS should consider potential impacts to AMD capture/treatment operations that will have to run concurrent with Pond 2S construction efforts. For example, should the deepening of Pond 2S occur while the Water Board's current AMD treatment program is underway, the loss of storage capacity provided by Pond 2S would increase the likelihood for the release of untreated AMD from the pond system to Leviathan Creek. Consideration of such potential impacts, and methods to mitigate such impacts needs to occur before selecting the proposed deepening of Pond 2S as a specific component of the Recommended Alternative.

In the absence of necessary data and information pertaining to the proposed deepening of Pond 2S, including the above-listed data and information, Water Board staff recommend against identifying the deepening of Pond 2S as a specific component to the Recommended Alternative. Rather, the FFS should identify the deepening of Pond 2S as an option to be considered during remedial design.

3) Locating the Treatment Plant at Pond 4: The FFS identifies the area adjacent to the current HDS plant near Pond 4 as the preferred location for the future HDS treatment plant. Water Board staff have identified data and information that is needed to support the proposal to locate the HDS treatment plant near Pond 4 as a specific component to the Recommended Alternative:

a) Although the FFS presents a number of slope stability analyses for the pond embankments (see Appendix B, Attachment E), no such analysis is provided in the geotechnical evaluation for the Pond 4 area (see Appendix C). Figure 5 provides a section through the Delta Slide that clearly illustrates that a layer of mine waste fills the gap between the 1940 topography and the 2009 topography. A slope stability analysis needs to be provided for the section shown in Figure 5 prior to selecting the Pond 4 area as the preferred location for the HDS treatment plant.

b) Appendix C includes the following statement, “Areas of slope instability exist in the mine waste slopes adjacent to this candidate site [Pond 4]. It is Wood’s understanding that the stability of the slopes will be evaluated and mitigated as necessary at a later date as part of the site-wide remedial actions.” This statement seems to suggest that construction of the HDS treatment plant at Pond 4 should be carried out before proper slope stability analysis has been conducted. Water Board staff do not agree with this approach and recommend that slope stability analyses of the Delta Slide area (for the section shown in Figure 5 to Appendix C) occur before the proposed action (locating the HDS treatment plant at Pond 4) is selected as a specific component to the Recommended Alternative.

c) As presented in Table E3 of Attachment E (Slope Stability) to Appendix B (Preliminary Design Brief, Ponds 1 through 4 Storage Alternatives), the downstream embankment for Pond 2N does not meet slope stability criteria for the pseudo-static condition. Because Pond 2N did not meet the required minimum factor for the pseudo-static condition, AR conducted a dynamic deformation analysis to estimate expected deformations at the top of the Pond 2N embankment under certain conditions. The last two pages of Attachment E to Appendix B, show that under the conditions analyzed by AR, a deformation of up to 16 inches at the top of the Pond 2N embankment could occur.

   Summit Engineering Corporation’s 2011/2012 survey reported the top of berm elevation for the Pond 2N embankment at 7,040.2 feet. Summit also reported that the maximum capacity elevation in Pond 2N at 7,038.8 feet. Water Board staff expects the Pond 2N liner extends to approximately 6-inches above the maximum capacity elevation to an approximate elevation of 7,039.3 feet. If the top of berm elevation deformed vertically downward 16-inches along the north side of Pond 2N (as mentioned above), the top of liner in this area would also drop 16-inches to an approximate elevation of 7038.0 feet. This condition could put the liner at a lower elevation than fluids stored in Pond 2N, thus allowing AMD to seep out of the pond, over the liner and into the embankment, further reducing slope stability. Resolution of this condition needs to occur before the proposed action is selected as a specific component to the Recommended Alternative.

d) Assessment of potential hazards to the Pond 4 area needs to include the saturated condition slope analysis for all pond embankments. Such analysis should be provided before the proposed action (locating the HDS treatment plant at Pond 4) is selected as a specific component to the Recommended Alternative.

e) Water Board staff recommend that AR provide an evaluation of potential inundation of the Pond 4 area, resulting from an uncontrolled release from upstream facilities (e.g., storage ponds, proposed sludge repository, stormwater conveyances, AD conveyance facilities, etc.) before the proposed action is selected as a specific component to the Recommended Alternative.

f) Water Board staff recommend that AR provide a comparative analysis of power requirements for an HDS treatment plant at Pond 4 vs the power requirements for an HDS facility at the Pond 1 candidate site before the proposed action is selected as a specific component to the Recommended Alternative.

In the absence of data and information pertaining to the Pond 4 area, as noted in the above-listed items, Water Board staff recommend against identifying the Pond 4 candidate site as a specific component to the Recommended Alternative. Rather, the FFS should identify both the Pond 4 candidate site and the Pond 1 candidate sites as possible locations for the treatment plant to be considered during remedial design.

4) Section 6.2.1 of the FFS and Appendix G (On-Site Power Evaluation) describe possible power-supply options to support the EFRA for OU-1 and identifies the use of off-site power sourced through Liberty Utilities as the recommended approach for providing permanent power to Leviathan Mine. Although it is not specifically stated, it appears that emergency backup for the off-site power feed would be provided by diesel generators. Water Board staff support this concept, but strongly recommend that the Recommended Alternative leave open the possibility of incorporating limited-scale solar power production. Water Board staff expect that limited-scale solar power production could be used as a power source for some of the proposed improvements under the EFRA for OU-1 (e.g., administrative facilities and various components to the treatment plant). Additionally, Water Board staff recommend revising the FFS to address the following comments:

   a) The November 15, 2016 letter from Liberty Utilities (Attachment B to Appendix G) is unclear as to whether the power would be sourced by Liberty Utilities or NV Energy. It appears that for the Nevada access road option, Liberty Utilities would only be responsible for construction and operation/maintenance of the power line between the CA/NV state line and Leviathan Mine. It appears that a point of connection near the intersection of Highway 395 and Leviathan Mine Road would be sourced by NV Energy. Appendix G provides no evidence that NV Energy is reasonably likely to participate in the project, either as the power provider or as a partner in constructing and maintaining a power line to from Highway 395 to the CA/NV state line. Documentation of which company will be sourcing the power at Highway 395 and NV Energy's willingness to participate in the project should be provided in the FFS.

   b) The FFS provides no discussion regarding State (California and Nevada) and federal commitments to reductions in the consumption of fossil fuels (the State of California - 100% clean energy by 2045, the State of Nevada - 50% clean energy by 2030 and 100% by 2050). Water Board staff understand that both Liberty Utilities and NV Energy incorporate renewable resources into their pool of power supply options. For the off-site power feed option, the FFS should include discussion of any renewable sources of energy that contribute power to the electrical distribution system at the proposed point of connection (intersection of Highway 395 and Leviathan Mine Road). This is certainly an important

consideration when weighing decisions regarding long-term power sources for the mine site.

c) Appendix G states that “Feasible area(s) for siting the solar array would need to be determined based on a concept design and geotechnical study”; however, Appendix G concludes that there is only enough usable area at the mine to locate up to twelve acres of solar panels. The basis for this conclusion is not supported in the FFS. The FFS should include a graphic that illustrates the areas that AR has determined to be potentially suitable for solar panels and provide information to support the conclusion that an additional nine acres of usable land area is not currently available or cannot be made available for solar panels (AR estimates that a total of twenty-one acres of land area would be adequate to generate enough power from solar to meet the highest energy demand scenario evaluated in the FFS, AR has already identified twelve acres of usable area, to another nine acres would bring the total to twenty-one acres).

d) Appendix G mentions that any risk associated with a possible loss of power from a power feed along the Nevada access road to Leviathan Mine can be mitigated by a standby generator and the proper use of storage capacity of the ponds. If this is the case, Water Board staff recommend revising the Net Present Value calculations for off-site power to include the costs associated with a backup diesel generator.

e) Water Board staff recommend revising Appendix G to include discussion of the public safety outage management policies of both Liberty Utilities and NV Energy and how those policies are expected to impact risk associated with possible loss of power from a power feed along the Nevada access road to Leviathan Mine.

5) Section 6.2.2 of the FFS and Appendix H (Leviathan Mine Access Road Improvement Evaluation) describe various road improvement options to support the EFRA for OU-1 and identify the Nevada access road as the recommended primary route for accessing the mine. Water Board staff agree with the determination that the Nevada access road should be identified as the recommended primary route for accessing the mine. However, to provide appropriate flexibility during Remedial Design, Water Board staff requests that specifics regarding the length of road to be paved or unpaved, and any geometric constraints that preclude adjustments in the horizontal and vertical alignment of the road to improve safety, be excluded from the Recommended Alternative.

6) Section 7.5 of the FFS and Appendix D (Sludge Repository Siting and Design) provide a detailed analysis of the sludge management alternatives. Based on this analysis, the FFS identifies on-site sludge disposal as the recommended sludge management approach. In the absence of necessary data and information pertaining to the construction and operation of an on-site sludge disposal facility, including, but not limited to the below-listed items, Water Board staff recommend against identifying the on-site sludge disposal as a specific component to the EFRA for OU-1.

a) Section 5.5 and Appendix D - See detailed comments (No.'s 45, 54, 64 – 72) on landfill construction and siting criteria, cost estimates and green energy assumptions. Water Board questions whether the building, operating and maintaining a sludge landfill on-site is in the best interest of the State of California. There are several deficiencies in the cost comparison, potential long-term environmental risks and costs as well as unresolved geotechnical issues that need to be addressed before this option could be considered by the Water Board. As the site property owner, the construction of a landfill on-site is a major decision that will impact the site in perpetuity.

7) The analysis for "Storage Tank(s)" as a means to "Reduce Storage Capacity" is misleading and incomplete in that it defines a single extreme case for the potential use of storage tanks for the storage of AMD, i.e., to provide the same storage capacity as that provided by the existing pond system. Certainly, the use of tanks at a reduced scale could provide an effective alternative to storing AMD in ponds. The comments pertaining to the effectiveness and implementability of storage tanks provided in Table 5-3 do not reflect the strategic use of a storage tank such as that described in Comment No. 1, above (i.e., as a means to provide initial storage of AMD source water when AMD influent to the HDS treatment plant exceeds treatment capacity), and/or in combination with extended treatment technologies including Reverse Osmosis and Ion Exchange.

   Water Board staff recommend revising Table 5-3 to reflect tanks, at some scale, provide a constructible and cost-effective means to safely store a range of fluid types, including corrosive fluids and non-potable water. Storage tanks also provide an effective means to reduce the required footprint for the storage of fluids. On a site where usable land area is limited, such as Leviathan Mine, storage tanks can provide an effective alternative to open pond storage. Storage tanks would be designed to withstand seismic forces as required by federal, State and local authorities. A wide range of effective corrosion-resistant products are available to protect the interior and exterior of tanks (be they steel or concrete). Manways are commonly installed in tanks to permit safe access for workers should interior servicing ever be required. Quality assurance/quality control will be necessary for tank construction as is the case for many of the proposed improvements contemplated by the FFS, including pond liners, embankments, and construction of the HDS treatment plant and appurtenances. Additionally, the relative cost of a tank is certainly competitive with the costs associated with utilizing existing storage ponds (which will require upgrades, including relining, to bring them into compliance with current standards) or deepening existing ponds. In the interest of maintaining what could be a valuable tool for the EFRA for OU-1, Water Board staff recommends retaining storage tank technology for additional consideration in remedial design.

8) The analysis for Reverse Osmosis (RO) and Ion Exchange (IX) as potential technologies for HDS effluent polishing is incomplete as it only considers a single treatment strategy wherein all of the effluent from the HDS treatment plant would be routed to either an RO or IX treatment facility. The FFS does not consider other possible strategies wherein only a portion of the HDS effluent is routed for additional

metals removal. Beneficial impacts resulting from a reduction in the required treatment rate through a RO or IX facility are discussed below. Water Board staff have also identified issues in the analysis provided in the FFS to estimate both the influent and effluent quality for the HDS plant (see Comment Nos. 15, 16, and 17, below). Until such time that AR addresses these comments, it would be premature to screen-out RO and IX technologies for HDS effluent polishing. In the interest of maintaining what could be a valuable tool for the EFRA for OU-1, Water Board staff recommend retaining RO and IX technology as possible options for HDS effluent polishing to be considered in remedial design. Water Board staff have the following additional comments and questions pertaining to the consideration of RO and IX technologies for polishing HDS effluent:

a) Page 31, Section 6.1.5 HDS-Effluent Polishing Technologies – As stated above, the analysis for RO assumes that all the effluent from the HDS treatment plant would need to be routed through the RO facility for polishing. These assumptions ignore other treatment strategies, including the reasonable possibility of treating only a portion of the HDS effluent. The analysis of treatment strategies wherein only a portion of the HDS effluent needs to be diverted for polishing is expected to result in significant reductions in the area needed to accommodate effluent polishing facilities, waste generation, and capitol and operational costs. Additionally, Water Board staff expect that the footprint associated with RO or IX technology would become much smaller if storage tanks were used instead of ponds for flow equalization and waste containment. These factors should be considered prior to screening out RO technology for HDS effluent polishing. While TDS and sulfate treatment are not part of the proposed project targeted constituents, any information related to their removal efficiencies with RO or IX should be included as they are constituents that will need to be addressed as part of the site-wide remedy.

b) Page 31, Section 6.1.5 HDS-Effluent Polishing Technologies – The possibility of using a Two-Stage RO system to reduce the volume of RO reject should be evaluated further. The volume of RO reject with a Two-Stage RO system could further reduce the volume by 80–90%. For example, for the maximum precipitation year with an 85% RO rejection rate, the total volume of RO reject would be reduced from 9.3 million gallons/year (MG/yr) to 1.4 MG/yr and for an average precipitation year the volume would be reduced from 4.8 MG/yr to 0.72 MG/yr. This results in a more manageable amount of truck traffic compared to the One-stage RO system with 1.2 trucks per day for max precipitation and 0.6 trucks per day for average precipitation for a twelve-month treatment season.

c) Page 31, Section 6.1.5 HDS-Effluent Polishing Technologies – There appears to be potential issues with high concentrations of Two-Stage reject that would result in gypsum and possibly other solid phases precipitating, causing scale formation on membranes and other RO system components. Water Board staff are aware that a multi-media filter was tested as part of the 2020 HDS pilot study. The FFS should consider the potential use of a multi-media filter or other filters as a means to mitigate potential issues created by Two-Stage reject. Additionally, the

FFS should provide the expected classification of reject from a Two-Stage RO system.

d) The text in Appendix C of the Technical Impracticability Evaluation (TIE) – Evaluation of Reverse Osmosis as a Polishing Technology, Section 4.14 states that there could be benefits to reducing the volume of the reject by reducing the transportation and disposal costs. However, it is also stated that reducing the volume of reject could result in increased metals concentrations in the reject that could change the waste classification from non-hazardous to hazardous. This change in waste classification would increase transportation and disposal costs. There is no additional information set forth in Appendix C to determine whether reducing the volume of reject provides a viable option, including by enhanced thermal evaporation, which should be explored more. Additionally, the locations identified for disposal of reject from RO (Texas and Ohio) do not seem realistic given the distances involved, especially without knowing how the reject will be classified. Without further analysis it would be inappropriate to rule out this technology at this time.

e) Page 31 and Appendix D to the TIE - Evaluation of Ion Exchange for polishing HDS Treatment Plant Effluent – IX was evaluated as a potential polishing technology for HDS treatment plant effluent. Although the feasibility of removing thallium with this technology remains in question, Water Board staff believe this polishing technology is promising to treat metals and sulfate and worthy of additional evaluation, including bench- and pilot-scale testing as recommended in the TIE report.

f) Page 31 and Appendix D to the TIE - There are statements that the IX system cannot be constructed at the site due to lack of suitable space for the IX polishing system building, equalization pond, and chemical and waste storage facilities. Again, these determinations assume that all HDS effluent will need to be routed through an IX facility at flow rates up to 250 gallons/minute, and that storage tanks are not an option. Further evaluation of the potential for treatment at reduced flow rates and the use of storage tanks instead of storage ponds is needed before the IX option is screened out. Regarding the regeneration of the Puromet MTS9300 chelating resin, the FFS should explain whether the hydrochloric acid and sodium hydroxide could be reused to regenerate the resin. It is premature to eliminate IX as a possible polishing technology at this time and the recommendations in the TIE report that a pilot or bench scale test is needed should be further evaluated.

Applicable or Relevant and Appropriate Requirements (ARARs) and Regulatory Issues

9) Pursuant to California Business and Professions Code section 6735, all civil (including structural and geotechnical) engineering plans, calculations, specifications, and reports (hereinafter referred to as “documents”) shall be prepared by, or under the responsible charge of, a licensed civil engineer and shall include his

or her name and license number. Interim documents shall include a notation as to the intended purpose of the document, such as “preliminary” or “not for construction,” “for plan check only,” or “for review only.” It appears that several of the documents included in the FFS constitute civil engineering documents. It is AR’s responsibility to comply with the above-cited requirements.

10) Page 19, Section 4.2, and Tables 4-1 and 4-2 – USEPA requested that the Water Board provide a list of the State’s ARARs for the EFRA in 2019. Water Board staff provided a full list of ARARs to USEPA on June 21, 2019. Water Board staff understand that USEPA has not provided direction to AR as to which State ARARs are to be complied with. The FFS does not utilize the list of ARARs identified by Water Board staff. This is a significant impediment to providing comments on the FFS or getting Water Board concurrence with the FFS, as there is no agreement on what requirements apply. It is Water Board staff’s understanding that the ARARs will be reviewed by USEPA in the development of a Proposed Plan for the EFRA and we look forward to coordination on this review.

11) The Remedial Action Objective (RAOs) and this FFS do not discuss or include ecological impacts or impacts to wildlife from surface water not meeting the screening criteria (which are based on MCLs and not background concentrations). Impacts to wildlife need further evaluation in the proposed EFRA for OU-1. Maximum Contaminant Levels (MCLs)s are human health protective drinking water standards and may not protect ecological receptors.

12) The TIE utilizes information from the FFS report to justify the request for waivers. In particular, the TIE request for a technical impracticability waiver for State Board Resolution 92-49 III.G appears to be supported by little if any technical justification and is not currently supported by Water Board staff. Before consideration of the waiver of any water quality objectives, there needs to be an evaluation of the 2020 HDS pilot study. At this time, Water Board staff cannot support a waiver of State Board Resolution 92-49 III.G or the State’s Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, State Implementation Policy (SIP).

13) Sludge characterization is needed to determine which siting criteria apply to the proposed landfill.

14) Water Board staff have identified several areas of the FFS that cannot be supported at this time without significant revision. It may be that portions of this EFRA should be identified as an interim remedy rather than a final remedy. The original scope of the FFS was for treatment of the five sources of AMD with a centralized HDS treatment plant for metals, and to leave sulfate and TDS removal to the site-wide remedy. The year-round capture and treatment of these five sources is the most important component of this FFS and is ready to move forward pending revisions to issues identified. To include surface water and groundwater as a final remedy is premature at this time and will result in significant delay of the most important part of this EFRA. Some of the most important areas which are deficient, or incomplete,

include site characterization of groundwater, limited risk assessment, a limited scope of removal action objectives not including ecological receptors, impacts from contaminated sediment and mine waste on surface water quality in OU-1, performance standards for effluent quality of the new HDS treatment plant, antidegradation and assimilative capacity of Leviathan Creek, and sludge characterization. Water Board staff will continue to work with USEPA to help support year-round capture and treatment of all five AMD sources, but, at least at this time, there are many components that need additional evaluation and overall make certain elements of this EFRA a much better option as an interim remedy.

HDS Influent and Effluent Calculation Issues

15) Appendix F (Predicted High Density Sludge Influent, Effluent, and Downstream Surface-Water Acid Drainage Metals Concentrations), states that evaluation of the 2012-2017 sampling data collected by AR from the five primary sources of AMD at Leviathan Mine indicates a "strong relationship between chemical concentrations and flow rates." The FFS needs to include evidence to support the statement that the relationship is strong. As part of this evidence, AR should provide the sampling data in the FFS so that the reader can assess the number of sampling events, timing of those events, and other pertinent factors. Without such evidence, it seems that the conclusion that a particular combined AMD flow rate would always produce the same chemical composition is questionable at best. It occurs to Water Board staff that the five AMD sources could produce a combined AMD flow rate that matches one of the flow conditions set forth in the FFS (i.e., low, average, and above-average), but with a completely different chemical composition than that which AR has selected to represent each flow condition. These variations in chemical composition are expected due to variations in the ratio of AMD flow from each source and in the chemical composition of each AMD source.

    For purposes of estimating influent quality, the development of flow regimes is not necessary. Water Board staff recommend AR's consideration of calculating influent quality by simply calculating the flow-weighted concentrations for each metal (for each sampling event). Once those concentrations are calculated, then the maximum concentration for each metal in the data set can be identified. Using the maximum concentration for each metal, the procedure in Section 4.2 could be used to estimate the HDS effluent concentration for each metal, provided AR addresses Water Board staff comments set forth in Comment No. 16, below. The estimates of maximum effluent concentrations provided in this manner can then be used in the procedure set forth in the SIP for calculating effluent limits.

16) Regarding the process used for estimating effluent concentrations as set forth in Section 4.2 of Appendix F, the FFS does not provide key information that is needed for purposes of evaluating the results for effluent quality, as follows:

    a) The FFS does not include the final results for the 2020 HDS pilot study or an explanation to understand those results.

b) The 2020 HDS pilot study involved a range of HDS configurations; yet the FFS does not explain which of the HDS configurations produced the effluent results that are used in the FFS for purposes of calculating effluent concentrations, or the basis for selecting that configuration and rejecting others. This information needs to be provided in a manner that allows the reader to link a calculated effluent value to a pilot test effluent value and the associated pilot test configuration.

c) Numerous assumptions that underlie the predicted effluent concentrations require additional information and justification for their use. The FFS notes that the dissolved concentrations were assumed to be the same as the pilot study effluent concentrations. However, it is not clear what those concentrations are since the specific plant configuration and associated data are not provided. It appears that the total suspended solids (TSS) concentration was also a conservatively assumed value of 15 mg/L and was further assumed to be the same composition as the sludge formed in the HDS treatment plant. However, the data has not been provided to check the TSS or sludge assumptions.

d) Appendix F, Section 4.2 provides the values used for all effluent calculations for saturation, mg/L as metal and is defined as “the effluent AD metal concentration observed during the 2020 pilot study. This assumes that the pilot study effluent concentrations were in equilibrium with the sludge produced.” It is not clear what information was used to justify the assumption of equilibrium for these calculations for the four flow regimes. Additional information is needed to evaluate these assumptions in the FFS.

e) The statement in Appendix F at the end of Section 4.2 that the “equilibrium between the dissolved and solid phases is not dependent on the influent AD metals concentrations but depends only on the setpoint pH of the HDS treatment plant reactors” also needs to account for the time it takes to get to equilibrium. How long does it take to reach equilibrium and what was the pH setpoint from the 2020 HDS pilot study?

f) The FFS predicts influent and effluent concentrations, but a review of these predictions raises questions regarding the appropriateness of these calculations. For example, looking at total arsenic, the FFS predicts influent and effluent concentrations for the four flow regimes which are reproduced in the table below.

	Low Flow (10^{th} percentile)	Average Flow (60^{th} percentile)	Above Average Flow (85^{th} percentile)	Peak Flow (99^{th} percentile)
Influent Arsenic (ug/L)	2,320	2,951	7,592	8,737
Effluent Arsenic (ug/L)	34	17	41	7.9

In this arsenic example, for the highest influent concentration, which occurs at peak flow, this corresponds to the lowest effluent concentration predicted, which is the opposite of what would be expected. The FFS needs to explain how the removal efficiency is so much better under peak flow conditions with the highest influent concentrations.

17) The approach for predicting downstream surface water concentrations set forth in Section 5.0 of Appendix F, ignores many of the considerations required by the State of California for determining effluent limits for the discharge of priority pollutants to surface waters. Without such consideration, Water Board staff fail to see the value in providing detailed comments on Section 5.0. Additional comments regarding the State of California's process for determining effluent limits, as specified in the SIP, are provided in Comment No. 22, below.

18) The FFS report should discuss the expected effluent quality for constituents not treated by the HDS treatment plant, including sulfate and TDS. At a minimum, this report should disclose the estimated concentrations from the HDS treatment plant and what is expected to be discharged as part of this project. This information should be included in the HDS pilot study report which has not been submitted to date.

19) This evaluation in the FFS is missing important information on treatment removal efficiencies and how this new proposed HDS treatment plant effluent will compare to the current HDS, Pond Water Treatment, and Aspen Seep Bioreactor effluent. How does the proposed project effluent quality compare to effluent quality from current treatment plants? Is the new HDS treatment plant capable of treating the AMD to a better level than current treatment plants? This information is critical in considering what additional environmental benefits this project will provide. Without this information and especially without the report from the 2020 HDS pilot study, Water Board staff are not able to complete our review.

20) The 2020 HDS pilot study focused on the treatment of AMD collected at the capture systems for the five AMD sources to be addressed by the EFRA for OU-1 (consisting of the Adit, Pit Under Drain, Channel Under Drain, Delta Seep, and Aspen Seep). The differences between AMD collected at the point of capture and AMD held in storage ponds are further described in Water Board staff Comment No. 1, above. The FFS should explain how AR intends to extrapolate the results of testing conducted on the treatment of AMD collected at the capture systems to the treatment of AMD held in the storage ponds.

21) The FFS should include a monitoring plan to demonstrate how effective the EFRA is in meeting water quality objectives.

Surface Water Issues

22) Following procedures outlined in the Lahontan Basin Plan, Water Board staff provided Water Quality Objectives (WQO) for Upper Leviathan Creek (ULC) for the

proposed discharge and attended several meetings on the evaluation process for the proposed discharge. None of the direction provided by Water Board staff nor the ARARs including the SIP has been included in the FFS. Surface water data exists for Upper and Lower Leviathan Creek and surface water calculations should be done using existing data. An evaluation is needed using ULC water quality objectives as background and a determination of Leviathan Creek assimilative capacity for the proposed discharge. Proposed surface water discharges are required to follow procedures in the SIP including mixing zones, assimilative capacity and anti-degradation. The FFS must be revised using the SIP to develop effluent limitations or other discharge criteria which reasonably protect beneficial uses and comply with the State and federal antidegradation policies. Instead, the FFS uses methods contrary to the SIP to estimate surface water concentrations downstream of the mine, when there is actual data that is required to be used to determine if there is any assimilative capacity in Leviathan Creek to meet state and federal anti-backsliding requirements and other applicable provisions of law. Water quality-based effluent limitations are necessary to control a priority pollutant in a discharge and must be developed to evaluate anti-backsliding and antidegradation. Water Board staff look forward to discussing these issues with the USEPA staff assigned to review the FFS as it does not appear to meet the substantive requirements of an NPDES proposed discharge. Additionally, the request for a TI waiver from meeting water quality objectives in the entire OU-1 for surface water is not supported as necessary evaluations of water quality throughout the reach and evaluation of impacts from sediment and potential treatment technologies in stream reaches in OU-1 has not been submitted. Since sediment is not included in this action, how will impacts on water quality from sediment and mine waste downstream of the mine be investigated and evaluated?

23) Due to the low or zero values for the 1Q10 and 7Q10 (1Q10 is the lowest 1-day average flow that occurs (on average) once every 10 years and 7Q10 is the lowest 7-day average that occurs (on average) once every 10 years) flows in Leviathan Creek, it is unlikely that conditions support the establishment of a mixing zone. In other words, at certain times of the year, Leviathan Creek flows are near or at zero, making it effluent dominated and likely not eligible for a mixing zone. The SIP process defines when dischargers can utilize mixing zones for determining compliance and if mixing zones are found to be inappropriate for any discharge, compliance is determined at the end of pipe. AR should include what the effluent concentrations are at the end of pipe as well as the receiving water concentrations and include this information in the tables comparing alternatives.

24) The location for surface water compliance (or background) has been set at SW-27; however, this location is not technically supported nor is there an evaluation of Upper Leviathan Creek as background. There are flaws in how concentrations are estimated at SW-16 and SW-27 because existing data at these locations should be used in the analysis and not estimated concentrations. For SW-27 estimated water quality, calculations are based on flow and concentration using Upper Leviathan Creek loading and flows at SW-15, for example. This approach ignores loading from groundwater that enters the surface water at these locations, dissolved sediments,

runoff, seeps or metals loading from contaminated areas upstream. The December 2017 AR Site Characterization Report (SCR) includes the following: “Floodplain soil that occurs in riparian areas along Leviathan, Aspen, and Bryant creeks may be affected by COPCs/COPECs [constituents of concern/constituents of potential ecological concern] through the transport and deposition of mine waste in surface water.” This statement acknowledges that surface water quality may be affected by the transport of mine waste to the stream bed, which is apparently ignored by the proposed use of SW-27 as background. Additionally, AR is proposing to use Upper Leviathan Creek for utility water needed in the HDS treatment plant and for drinking water for on-site workers but these additional water demands are not taken into account in the calculations. It is not clear how these additional water demands will affect the amount of flow used in the calculations provided.

Specific comments from the FFS

25) Page ES-1, second paragraph, first sentence – The text states: “OU-1 mine-influenced groundwater exists primarily in unconsolidated materials and largely reports to the ground surface….” The extent of groundwater impacts has not yet been identified, particularly for the 20 RI/FS constituents of concern (COC)[1]. The Water Board staff and DRI submitted comments on the most recent groundwater reports and the Water Board has yet to receive comments or input from USEPA concerning this issue.

26) Page ES-1, last paragraph, first sentence – The text states: “Groundwater ICs will consist of use restrictions that prohibit installation of on-site groundwater wells for domestic use.” This would not prohibit the installation of groundwater wells for domestic use on nearby private properties. Plate 7b in the *Evaluation of Groundwater Conditions*, dated January 11, 2021, shows that there is the potential for migration of bedrock groundwater from the site towards private property to the west.

27) Page ES-2 Last bullet and page 33, Section 6.3, third paragraph – Institutional controls does not mention an institutional control for groundwater that restricts the use of groundwater in the defined groundwater plume area which would be a necessary element and potentially requires restricting use on private property not owned by AR or the State. Nearby private parcels could still install domestic wells. Groundwater maps show potential movement of groundwater and contaminants from the impacted areas of the site towards these private parcels. If a TI waiver is granted, the elements of a containment zone must also be demonstrated as required in State Board Resolution 92-49.III.H.

28) Page ES-4 Last paragraph – Reverse Osmosis should be retained as a potential HDS effluent polishing technology. The statement that the concentrated brine (RO

[1] RI/FS COC metals: aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), hexavalent chromium (Cr[VI]), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), vanadium (V), and zinc (Zn)

reject) generated by RO must be disposed of off-site neglects to consider potential on-site disposal and management of the brine. The calculation of off-site disposal costs for the RO brine via deep well injection in Texas and Ohio seems exorbitant since disposal options are available in California. The brine has been identified as a non-RCRA, non-California hazardous waste and could be managed on-site or off-site at much closer locations. In addition, since this FFS is solely for the COC metals and not for sulfate or TDS, the FFS should clearly state that the technology will be re-evaluated at a later date for treatment of sulfate and TDS.

29) Page ES-3, seventh bullet and page 33, Section 6.3, fourth paragraph – The Institutional Controls (ICs) for surface water consisting of signage placed along Leviathan and Bryant Creeks advising against human activity that could result in unacceptable exposure to contaminated surface water appears inadequate at this time. Signage does not appear to be a sufficient protective remedy to expect people, plants, and animals to avoid Leviathan and Bryant Creeks.

30) Page ES-4, first bullet – The ICs for groundwater are limited in scope and are not fully protective of future human health impacts. There are other landowners both upstream and downstream of the Leviathan Mine site that reasonably could drill a domestic well for drinking water and the land use covenant for on-site would not effectively preclude this potential future practice. Additionally, the Water Board may determine that a groundwater well is needed for utility water and other water needs for treatment and other operations and maintenance needs. Water Board staff need to better understand if any future land covenant could preclude this potential need in the future. For example, if the Water Board may decide to use a proposed Reverse Osmosis plant on groundwater rather than Upper Leviathan Creek for domestic water needs on-site?

31) Page 6, third paragraph – The text infers that spring treatment is only needed following “unusually wet winters.” Spring treatment is needed approximately 29 percent of Spring seasons. Implying or suggesting that over a quarter of the winters are “unusually wet” is not accurate. “Above average” may be a better term to use.

32) Page 7, footnote – This definition of mine-influenced groundwater is still under discussion and has not been agreed upon by all parties.

33) Page 8, Section 2.1 – There are unresolved comments on all the documents listed in this section. It is not appropriate to present the documents here as a summary without resolving those comments.

34) Page 9, Section 2.1.4, second bullet, last sentence – The text states: “Mine-influenced groundwater daylights as part of the surface-water flow at the pinch out of native unconsolidated deposits at the bedrock outcrop approximately 500 feet downstream of the confluence of Leviathan and Aspen creeks.” The *Evaluation of Groundwater Conditions* report relies heavily on this concept of all mine-influenced groundwater daylighting at this bedrock outcrop. However, this hypothesis has not yet been proven. There are no groundwater monitoring wells downstream of this

outcrop to confirm that there are no groundwater impacts in this area. Additionally, Water Board staff have investigated the bedrock outcrop in question, and it is highly fractured which could allow mine-influenced groundwater to travel within the bedrock aquifer even if the unconsolidated deposits pinch out in this area.

35) Page 9, Section 2.1.4, Evaluation of Groundwater Conditions 2020 General – Water Board staff and our consultants, Desert Research Institute (DRI), have provided extensive comments on S.S. Papadopulos and Associates' (SSPA) January 11, 2021 *Evaluation of Groundwater Conditions, Leviathan Mine, Alpine County, California* (see DRI's comments in Attachment B). DRI's comments detail areas where the groundwater system is not fully characterized including lateral and vertical extent of the plume, background water quality, vertical flow, etc. In order for the Water Board to support inclusion of a final remedy for groundwater in the EFRA, an adequate characterization of the groundwater is needed, including responses to the DRI's comments. Furthermore, without an adequate characterization of groundwater, Water Board staff does not support a TI waiver for groundwater.

a) In the June 23, 2021, USEPA letter to AR, USEPA provided direction to AR regarding the FFS. The extent of OU-1 is identified for both surface water and groundwater as the entire Leviathan Creek watershed. Water Board staff believes at this time that it is inappropriate to use this delineation for the groundwater or surface water extents in OU-1. Water Board staff believe there is not enough information at this time to delineate the extent of groundwater contamination to support a TI waiver and any associated containment zone as required by State Board Resolution 92-49 III.H. Such data is reasonably obtainable with additional investigation. Evaluations of existing surface water quality or impacts of sediment on water quality or possible treatment technologies throughout the proposed OU have not been submitted.

b) The FFS uses a methodology to determine a background value for sulfate, but that approach improperly includes wells impacted by mining activities (see Table 4.1 in Appendix A). The selection and use of 200 mg/L sulfate to delineate the groundwater plume does not support a sufficient site characterization as to mine-impacted groundwater. Background conditions must be determined using non-impacted wells and compared to downgradient well(s) concentrations to define the extent of groundwater contamination. A review of the reference threshold value (RTV) process approved for the site-wide RI/FS revealed that the same issue exists in the well selection for calculating RTV's. The well set used to calculate RTV's for the unconsolidated aquifer includes MW-11, 45, 46, 43, 50, 51, 53 and PZ-33. Wells MW-11, 43, 51, and 53, are downgradient of existing contamination, potentially impacted, and inappropriate for use as background wells. MW-46 is finished in a sulfur rock impacted by drilling that makes it inappropriate for determining background. As a check of the methodology, Water Board staff conducted an analysis following the approved RTV process for wells MW-34, 45, 48, 49, 51, and PZ-33 that resulted in an RTV for Sulfate of 136 mg/L. As a result, the RTV process can be used to develop background values for groundwater using unimpacted wells. The fundamental issue of what

constitutes background and which wells are appropriate for use as background wells must be resolved prior to consideration of groundwater as a possible final remedy as part of the EFRA.

36) Page 14, Section 2.5 Data Sufficiency for Final Groundwater and Surface Water Remedy – The groundwater has not been fully characterized. Please see DRI May 2021 comments (Attachment B) on new wells needed to define the extent of the plume both horizontally and vertically.

37) Page 15, Section 3.1, Second paragraph – The text states: “Other smaller and diffuse AD discharges occur at the Upper Aspen Seep and seeps located on the portion of the LCBL near Aspen Creek downslope of the mine waste.” It is important to note that there are also other uncaptured AD discharges on the Leviathan Creek side. The text also states: “Under most flow conditions, the smaller, diffuse discharges infiltrate a short distance downslope from the point of discharge and do not directly affect surface-water quality.” It is not unusual for uncaptured AD discharges on the Leviathan Creek side to flow directly to surface waters. Examples of these seeps include the seep located along the Pond 3 access road (commonly referred to as the “crusher road seep”), the seep originating from the slump repair near Pond 4, and the hillside seep southeast of Pond 1 located downhill from the Water Board’s decontamination trailer, among others. These seeps should be mentioned in this report and acknowledged that this project will not address them. This section goes on to state that some of the seeps in the Leviathan Creek Basin Landslide are neutralized in groundwater due to the buffering capacity of carbonate materials in the subsurface. To Water Board staff’s knowledge, no data has been provided to demonstrate this presumed buffering capacity.

38) Page 15, Section 3.2, Groundwater Occurrence and Flow – The text states that groundwater flow in the bedrock is significantly less than that of the overlying mine waste and native materials. However, the extent of the bedrock flow has not been characterized; see DRI comments (Attachment B) submitted in response to the January 11, 2021, report titled *Evaluation of Groundwater Conditions*.

39) Page 16, Section 3.3, Extent of Mine Influenced Groundwater – The extent of mine influenced groundwater at the site has not been adequately delineated. Please see DRI May 2021 comments (Attachment B) submitted in response to SSPA’s January 11, 2021 *Evaluation of Groundwater Conditions, Leviathan Mine, Alpine County, California.* Also see the USEPA’s Statement of Work, for the RI/FS (Section A.1.g) which requires “contours of COC in groundwater”.

40) Page 17, Section 3.4, Downstream Surface Water Quality first paragraph – The discussion here describes the assimilation capacities of the Leviathan Creek watershed by dilution with tributaries. The process of determining the water quality downstream of a surface water discharge is defined in the SIP which was identified as an ARAR by Water Board staff in June 2019. If AR is interested in the establishment of a mixing zone, AR should submit a mixing zone study, assimilative capacity and anti-degradation analysis to evaluate the proposed discharge.

41) Page 17, Section 3.5, No. 3 – The conclusion presented in No. 3 is not supported and DRI has detailed this issue in their May 2021 comments (Attachment B). Questions and comments presented regarding unconsolidated groundwater pinching out at this bedrock outcrop have not yet been addressed.

42) Page 19 Remedial Action Objectives – Water Board staff provided comments on the RAO which have not been addressed.

43) Page 22, Section 5.0 General Response Actions and Technology Screening – The No Action Alternative for this screening exercise should be no action other than the current response action, which includes the current removal actions. Relative costs should include Operation and Maintenance costs and have not been evaluated for several alternatives including tanks versus surface impoundments and on-site landfill operation and maintenance versus off-site disposal.

44) Page 33, Section 6.3 ARAR Waivers – The request to waive ARARs is premature as the HDS pilot study has not been submitted to provide the engineering and technical justification to support a technical impracticability request to USEPA. Additionally, Water Board staff cannot support a waiver of groundwater ARARs at this time as the groundwater has not been adequately characterized to support a waiver.

45) Page 33, Section 6.3, fourth paragraph and page 49, Section 7.5.1.2 Cost Estimate – The landfill operating cost estimate is low for the following reasons: (a) operation and maintenance costs for a landfill are significant and are not adequately captured in this cost estimate. (b) operation and maintenance costs should be obtained from operating landfills; (c) Cost should include costs of a closure cap; (d) costs should be included for long term and perpetual costs of monitoring and maintenance; (e) liner costs for a single liner system need to be upgraded to at least a double liner system; and (f) leachate monitoring, collection and treatment costs in perpetuity need to be included.

46) Page 35, Section 7.1.2.2, first paragraph – This section describes Alternative AD-1: No Action. Water Board staff agrees that the No Action alternative provides a baseline for comparison to the other alternatives. However, the No Action alternative represents no further action from current response actions ongoing at the Leviathan Mine site. If no action was taken as part of this proposed project, AMD would still continue to be captured and treated year-round for the Adit, Pit Under Drain, and Aspen Seep, and seasonal capture and treatment would continue for the Channel Under Drain and Delta Seep. Both Water Board and AR are under USEPA orders to conduct certain removal actions which include treatment of the five AMD sources. Current conditions are not adequately represented with the alternative AD-1 and are not appropriate for comparison to the proposed alternative AD-4. This alternative analysis needs to be revised to include an evaluation of the expected environmental benefit from the proposed project compared to current conditions needs to be presented. The results of the incorrect application of a No Action alternative appear to have overestimated the environmental benefits from alternative AD-4.

47) Page 56, Section 8.2 Estimated Risk Reduction – Water Board staff and the OEHHA (Attachment C) have identified the following issues with the risk reduction analysis:

a) Revising the No Action Alternative to the current condition to characterize the environmental benefit from this proposed project compared to what is currently occurring at the site. This would result in a more appropriate and realistic risk reduction evaluation of this project compared to current conditions.

b) The Upper Leviathan Creek (ULC) WQOs have been developed by Water Board staff in conformance with the Water Quality Control Plan for the Lahontan Region (Basin Plan) and provided to USEPA and AR for use as background water quality for the Leviathan Mine. The development of a risk reduction estimation using downstream data as a background condition is not supported by Water Board staff. The chosen location SW-27 is miles downstream of the proposed discharge and is potentially impacted from past discharges of mine waste. Please see comments provided by OEHHA on the AR estimated risk reduction (Attachment C).

c) OEHHA staff's evaluation of the AR risk reduction assessment determined the implementation of year-round treatment does not improve water quality using the methodology proposed by AR for most metals.

d) Additionally, the predicted effluent concentrations are needed for all dissolved and total metals, not just the ones that have human health or aquatic receptor screening criteria as is currently provided.

48) Table 4-2 State Requirements – The table does not include many of the ARAR's identified by Water Board staff and submitted to USEPA. The missing ARARs are too numerous to list in this comment letter. Please refer to the June 21, 2019 Water Board letter to USEPA which includes all of the ARAR's identified by Water Board staff. For example, some of the missing or incomplete ARARs include: Title 27 siting and construction requirements for landfills and surface impoundments; State Board Resolution 92-49 referencing only section III.G; no reference to the SIP; only referencing Chapter 3 of the Lahontan Basin Plan; as well as ARAR's identified by other state agencies including the Department of Toxic Substances Control, and the California Air Resources Control Board.

49) Table 5-1:

a) Institutional controls for groundwater may be difficult if not impossible to implement since the extent of the contaminated groundwater plume has not been defined.

b) Collection trenches are rejected but are currently installed at the Delta Seep and Water Board staff do not understand why the installation of collection trenches should be rejected for other portions of the Site. Water Board staff would appreciate additional explanation in the FFS.

c) Collection at discharge locations only includes collection of the five sources and does not include collection of additional seeps identified by AR and identified as potential actions to improve collection along with other actions like revegetation included in PPSA's January 11, 2021 report titled *Evaluation of Groundwater Conditions, Leviathan Mine, Alpine County, California*.

d) Groundwater containment is rejected but some areas have been identified by DRI May 2021 comments (Attachment B) where containment could be implemented

50) Table 5-3, Expand Storage Capacity, Expand Existing Ponds, Implementability- Table 7-6, Protect Human Health and the Environment, Alternative SM-1 – Off-site disposal risks may be the same, or less, than on-site disposal risks and this section warrants additional explanation. For example, there is potential for the on-site landfill/surface impoundment liner to leak, the decant collection system to plug and though unlikely, dam failure to occur.

51) Table 5-5, Disposal, Off-site Disposal Facility, Implementability – Would truck traffic increase considering the sludge would be generated from a HDS plant, not a LDS plant as it is for half the sludge now? Why would truck traffic potentially be year-round?

a) The use of electric trucks for transporting sludge needs to be included in the evaluation as this would reduce the environmental impacts from greenhouse gases significantly. The use of electric semi-trucks to transport waste off-site is becoming more commonplace. The Port of Oakland is currently using them in a new program and manufacturers are currently releasing new models of electric trucks making it more implementable and worthy of inclusion in this evaluation.

b) Disposal off-site is ranked a higher cost than on-site disposal. Water Board staff has a number of concerns with the calculation of costs associated with operating a landfill. For example, 10 hours/year for maintenance appears inordinately low, the cost of treating leachate generated is not mentioned, and the cost to close with a cap, and closure/post closure monitoring were not included. As a result, the on-site disposal cost estimate needs revision, see comment No.'s 82 - 84 for additional details.

52) Table 6-2– Estimated HDS effluent quality varies with changes in influent flow/concentrations. Treatment plants are generally designed to handle changes in influent flow/concentrations by modifying operational settings to obtain a consistent effluent quality. It is unclear why the HDS plant design does not include the ability to produce consistent effluent quality.

53) Table 6-2, Table F-7, Table L-1, and Table L-2 – These tables use a mixture of total and dissolved concentrations for the metals. It appears that these tables use either total or dissolved based on the screening criteria that is being applied. Please

include tables that have all dissolved and all total concentrations included in this FFS report.

54) Table 7-6 –This table does not address the environmental risk inherent in potential landfill failures, as well as geologic siting criteria and any deficiency issues including liquefaction, slope stability, landslide potential.

a) Long-term effectiveness of a landfill ignores issues with closure cap maintenance, requirements for leachate monitoring, removal and treatment, on-going landfill monitoring. Off-site disposal does not have any long-term effectiveness issues.

b) System flexibility indicates that during a wet year there would be sufficient capacity since there is available freeboard. The requirement to maintain 2-3 feet of freeboard in a surface impoundment is not to allow for its use during a wet year. Freeboard is required to be always maintained to ensure that there are no surface discharge of acid mine drainage from one or more the ponds. If the pond is at capacity, there would need to be another plant to handle sludge generation, fixed capacity surface impoundments are not flexible.

c) Sustainability/Environmental footprint assumes diesel powered trucks but a requirement to use electric powered trucks changes the footprint and should be considered. Sustainability of an on-site landfill should consider liner leak potential, long term leachate and closure cap management, long term monitoring, as well as geologic issues including landslides, liquefaction and slope stability.

d) Control of residual risk, on-site landfill includes a residual risk of releases for in perpetuity. Potential for releases into the Leviathan Creek watershed should be evaluated. Hazardous waste sludge has been disposed of at a Class 1 hazardous waste landfill for at least the last 20 years.

e) Type and quantity of residuals – It is unclear how the volume of sludge generated in the landfill is deemed to be less than the volume of sludge generated in the drying beds.

f) Average annual O&M of $29,000 seems extremely low for a landfill. This number should be explained and compared with actual landfill operating costs including leachate monitoring, disposal operations, inspection and monitoring requirements, and equipment maintenance.

55) Table 7-7 – Water Board staff has questions about the ranking of off-site vs. on-site disposal in the following bullets and request the ranking be revised. On-site disposal is ranked extremely high (18 vs 8) in long-term effectiveness and performance in comparison with off-site disposal.

a) An on-site landfill requires long-term operations and maintenance, and also poses environmental risks associated with potential dam failure, landslides,

liquefaction, and liner leaks. These costs and on-site risks are absent with the off-site disposal option at a permitted landfill.

b) An on-site landfill carries an environmental risk in perpetuity whereas off-site disposal risks associated with transportation are short term. The evaluation should be revised to more accurately report long-term issues with an on-site landfill.

c) An explanation of why the implementability of on-site disposal scores higher than off-site disposal is needed. Constructing an on-site landfill is a much more significant undertaking than loading sludge into trucks for off-site disposal.

Appendix A Evaluation of Groundwater Conditions

56) The Water Board contracted with DRI to review the SSPA's January 11, 2021 *Evaluation of Groundwater Conditions, Leviathan Mine, Alpine County, California.* DRI prepared review comments (see Attachment B) and met with AR and PPSA on multiple occasions to discuss their comments. None of the DRI comments have received a response either in writing or by revisions to SSPA's report. Water Board staff is requesting that AR and their consultants respond to the DRI comments. At this time, Water Board staff cannot support the current conceptual site model submitted with the FFS as part of a final proposed remedy for groundwater because it does not sufficiently characterize the extent of groundwater contamination.

57) Page 42, Table 4 – This table contains a selection of wells with pH >6.5 to justify selection of 200 mg/L sulfate as the background concentration used to define the extents of contamination. This process ignores that some of these wells are downgradient or in the middle of the site (MW-20, 22, 42, 30, 50, 11, 41, 47, 43, PZ-07, DPZ-20,54) and potentially impacted by upgradient contamination. Resolution 92-49 requires that dischargers to clean up and abate the effects of discharge in a manner that promotes attainment of background water quality, or the best water quality which is reasonable if background water quality cannot be restored. There is no justification for using potentially impacted downgradient wells to determine background concentrations. Also, there has been no response concerning previous Water Board comments on wells that have construction issues such as failed grout (ex. MW-41, MW-47) which likely impacts COC concentrations. Background levels for all COC's should be developed with data from wells unimpacted by legacy mining activities. The absence of background concentrations for COCs in the FFS leaves the Water Board without the necessary information to concur with many of the conclusions in the report.

Appendix B Preliminary Design Brief, Ponds 1 through 4 Storage Alternatives

58) Page 11, Section 3.5.1, fourth bullet – Contrary to what is stated in the text, the Water Board did implement remedial construction measures at the slump located northeast of Pond 3 during the 2017 field season. These remedial measures included the installation of subsurface drains, regrading of the head, and installation

of a lined ditch near the toe of the slump. Water Board staff continue to monitor this slump.

59) Page 14 Section 6.0 Slope Stability Evaluation – The slope stability evaluation must be consistent with the minimum requirements contained in California Code of Regulation (CCR), Title 27, section 21750, subdivision (f)(5). The stability analysis shall ensure the integrity of the waste management unit, including its foundation, final slopes, and containment systems under both static and dynamic conditions throughout the life of the unit, including the closure period and post-closure maintenance period. The stability analysis shall address all portions of the waste management unit and its immediate surroundings that are located in areas subject to liquefaction or unstable areas with poor foundation conditions. The analysis must indicate a factor of safety for the critical slope of at least 1.5 under dynamic conditions. Please include a description of the various assumptions and parameters used in the analysis.

60) Groundwater exists at the bedrock/overburden and bedrock/waste rock interfaces and creates an unstable condition presenting the potential for slide planes to develop. This issue needs additional discussion and evaluation in the stability analysis for any proposed waste management unit.

61) Water Board staff recommends using the Guidelines for Evaluating and Mitigating Seismic Design Hazards in California, California Geological Survey, Special Publication 117 as a guidance document for the stability analysis for all proposed waste management units.

Appendix C Preliminary Geotechnical Evaluation of Candidate Sites for an HDS Treatment Plant

62) Some fault evaluation was performed but the FFS does not provide an evaluation of faults found on-site and reported in the SCR. All faults found on-site and reported in the SCR should be evaluated.

63) Figure 9 of Appendix C should be updated to reflect the magnitude 6.0 earthquake that occurred on July 8, 2021, near Antelope Valley, which resulted in very noticeable shaking at the mine site as well as rockfall from the pit highwalls.

Appendix D Sludge Repository Siting and Design

64) The sludge disposal unit should be referred to as a waste management unit as defined in Title 23 or 27.

65) Water Board staff does not understand what sludge quality information is being relied upon to support classification of the sludge as a non-hazardous waste when it has long been disposed at a hazardous waste landfill in Beatty, NV. If characterized as hazardous waste and a waste management unit is constructed, certain requirements in Title 23 will likely be triggered.

66) The analysis is incomplete because there was no cost comparison or alternatives analysis of the off-site disposal option versus the on-site disposal option which considers ongoing operation and maintenance costs of a landfill as well as closure costs. Please also note that operation of a landfill or surface impoundment is a year-round endeavor.

67) CCR, Title 27, section 21400, subdivision (b) requires mandatory clean closure attempt for surface impoundments. If after reasonable attempts to remove the waste, it can be demonstrated that clean closure is infeasible, a surface impoundment may then be closed as a landfill pursuant to CCR, Title 27, section 21090. Please provide the justification for why clean closure is infeasible and closure as a landfill is warranted.

68) It is unclear if the sludge will be pumped to the disposal unit as a liquid or mechanically delivered as a solid or cake. If the sludge contains liquids, the disposal/treatment unit needs to meet surface impoundment design criteria and not landfill criteria or both as landfills cannot accept waste that cannot pass the paint filter test such as a sludge containing 85% liquids.

69) The executive summary to the FFS has conflicting information about the proposed liner once being referred to as a single liner and then as a double liner with leachate collection. The document should be consistent in references to the proposed liner configuration.

70) If a landfill or surface impoundment is part of the proposed remedy for the early final remedial action, the action would need to meet specific siting requirements and construction standards. For example:

a) All new landfills and surface impoundments must be sited, designed, constructed, and operated to ensure that wastes will be a minimum of 5-feet above the highest anticipated elevation of underlying groundwater (CCR, Title 27, section 20240).

b) If the waste discharged to the surface impoundment is classified as a designated waste, then additional siting and construction criteria for Class II waste management units outlined in CCR, Title 27, section 20250, would be applicable, including a 200-foot setback from any known Holocene fault.

c) Construction standards for the different types of waste management types are summarized in Table 4.1, CCR, Title 27 and more clearly defined in CCR, Title 27, section 20310 through 20377. The waste classification will determine which type of waste management unit will be constructed.

d) CCR, Title 27, section 21750, subdivision (f)(7) shall identify any known Holocene fault within 200 feet of the waste management unit (including any portions of such a fault underlying the Unit) in accordance with a procedure approved by the Water Board; and shall provide a review of historical seismicity within a 100 km (62 mile) radius of the facility. Please provide a map showing all

known faults on-site and indicate whether any are Holocene active, in addition to a review of historical seismicity in accordance with CCR, Title 27, section 21750, subdivision (f)(7).

71) Section 5.2 Preliminary Sludge Repository Design Overview, 7th bullet – Utilizing the sand protective layer material removed from the abandonment or improvement of existing ponds would not be feasible considering the sand is composed of mine waste, is acid generating, and would be contaminated with metal hydroxides and salts precipitated from the storage of AMD.

72) Section 5.2 Preliminary Sludge Repository Design Overview, 13th bullet – The Pit Under Drain is quite shallow in depth as it exits the cutoff wall located under the existing gate in the pit throat. Extra loading from a dam built on top of this shallow pipeline would potentially need to be mitigated.

Appendix E High Density Sludge Plant Conceptual Design

73) Water Board staff believe it would be beneficial to investigate a treatment plant design that incorporates two parallel treatment trains. This approach would allow maintenance to be performed on one of the trains while the other continued to neutralize AMD. If each of the parallel treatment trains were sized appropriately, this design may allow a higher treatment rate if both trains were used concurrently as might be necessary in a situation such as spring of 2017 when it would have been advantageous to reduce the stage in the storage ponds in anticipation of incoming storms. Although parallel treatment trains would be more costly to construct, they would increase maintenance flexibility, provide redundancy, and be more protective of water quality and the environment.

74) Page 1, Section 1, second paragraph, last sentence – This text states that the sludge will be disposed of in the pit in a proposed sludge landfill and the decant water will be discharged to Leviathan Creek. The FFS is inconsistent in its presentation of decant and filtrate facilities for the proposed sludge repository (surface impoundment). The text of the FFS refers to a decant structure that is not presented in the conceptual drawings provided as Appendix D (Preliminary Facility Layout and Construction Details), and the conceptual drawings include details for a filtrate collection and conveyance system that is not mentioned in the FFS text.

75) Page 6, Section 2.6, 10th and 11th bullet – This evaluation expects to have freshwater available year-round from Upper Leviathan Creek for use in the HDS treatment plant with a flow rate range of between 0.7 gallons/minute–2.419 gallons/minute. While the design is not included in the HDS Conceptual Design, it is included and expected as part of this recommended alternative that a potable water system to treat water from Leviathan Creek with Reverse Osmosis for domestic purposes would cost approximately $100,000.00 depending on desired capacity. This information was not included in the evaluations for effluent discharges to surface water and compliance points downstream.

Appendix F Predicted High Density Sludge Influent, Effluent, and Downstream Surface-Water Acid-Drainage Metals Concentrations

76) The evaluation of any potential mixing zone does not follow the procedures as detailed in the SIP which was identified by Water Board staff as an ARAR in 2019. This Appendix needs to be rewritten using the SIP. The process contained in Appendix F is not supported by the SIP for determining surface water concentrations downstream of the proposed discharge. Specifically, the mass balance calculations using flow from one site and water quality concentrations from another site do not provide an accurate water quality result. Existing flow and water quality data for these sites should be used in all calculations. Using a location downstream of mine impacts (SW-27) as background is not supported by the Water Board.

77) Page 2 and 3, Section 4.1 – There are inconsistencies with the influent AMD between what is being proposed and what is being calculated. The calculations presented assume that only AMD as source water is being treated rather than the AMD from the five sources that is stored in ponds with additional direct precipitation added which is not accounted for in the calculations. The calculations for the influent should be consistent with proposed alternatives. The calculation relies on average daily flow rates for all of the AMD sources except for the Pit Under Drain; it is assumed this is a typo in the calculation that will need to be corrected.

78) Page 3, Section 4.2 – This section includes the methodology used to calculate the predicted effluent concentrations. The statement “Representative effluent concentrations for AD metals were calculated using the combined metals the results of the HDS treatability study conducted during 2020, the results of which will be documented in a separate report” is incorrect as the 2020 HDS treatability study has not been provided for review. As a result, the Water Board staff is unable to evaluate how similar the calculated effluent concentrations are to the results of 2020 HDS treatability study. In addition, Water Board staff question the validity of the assumptions used in the calculations including: (1) the effluent TSS concentration of 15 mg/L, and (2) the assumption that the pilot study effluent concentrations were in equilibrium with the sludge produced. This value is an input to all calculations used (s*aturation mg/L as metal*), and to evaluate if the effluent quality is actually not dependent on the influent metals concentrations since equilibrium is assumed to be reached between solid and dissolved phases and is only reliant on pH.

79) Page 5 through 7, Section 5.0 – There are flaws in how water quality was estimated at SW-16 and SW-27. For SW-27 estimated concentrations, the calculations are based on flow and concentration. However, these estimated concentrations only account for loading coming from Upper Leviathan Creek, Upper Aspen Creek, and Mountaineer Creek. None of the groundwater that enters the surface water is accounted for in this calculation, nor are any seeps or metals loading from contaminated areas upstream. For Leviathan Creek, the concentration at SW-15 should be applied to Station 15, rather than the concentration from Station 1 above the mine site. Similarly, for Aspen Creek, the concentration downstream of the mine site should be applied to the flow from downstream of the mine site. Not only do

these calculations not follow the SIP, but they underestimate the current mass loading in Leviathan, Aspen and Bryant Creeks and result in potentially underpredicting the chemical concentrations at the SW-16 and SW-27 locations.

80) Water Board staff do not understand how AR is estimating “background concentrations” located approximately two miles below Leviathan mine that has been impacted by contaminated surface water, sediment and groundwater. Background should be represented as Upper Leviathan Creek, upstream of any on-site contamination and is the receiving water to which the proposed HDS plant effluent will be discharged.

Appendix I Sludge Management Calculations

81) Appendix I, Table I-1 – It is unclear if the “Acid Drainage” volumes listed in the table include direct precipitation from in the ponds or if this volume is simply the source volumes. Because the text discusses open storage ponds, direct precipitation should be included in the total volume of water to be treated by a treatment plant and this may impact the volume of sludge produced.

Appendix J Detailed Cost Estimates

82) The cost estimate included in this appendix for constructing a landfill is $8,657,730, and in the body of the report the cost estimate is reported at $5 million +. In addition, these cost estimates do not include costs to close a landfill (cap), monitor and maintain the cap in perpetuity, manage leachate in perpetuity nor design work (and other indirect costs) which is estimated at over $2 million making the real cost estimate of the landfill over $10 million. Operation and maintenance costs to operate either a surface impoundment or landfill are underestimated and will be a significant cost in perpetuity. The FFS should be revised to correct these estimates.

83) Operation of surface impoundments should be included in the cost estimates for chosen alternatives. In addition, the cost to re-line the ponds should also be included.

84) Table J-14, Operation and inspection estimate for a landfill or surface impoundment at 10 hours per year is significantly underestimated. Typical inspections are 1/week for liner; pond freeboard and leachate collection systems are daily. Leachate systems for landfills manage leachate by pumping to ensure liner does not see over 1 foot of head on the liner. Surface impoundments have an Action Leakage Rate for required pumping leachate out of its secondary liner system. The estimate should be approximately 10 hours per week and the costs, volumes for treating leachate should be included in O&M costs. Landfill operations also include waste management to place and compact the waste and level the operation face. These elements need to be added to the daily operations cost.

Appendix K Environmental Footprint Analysis for Sludge Management Alternatives

85) This appendix does not include any text or description of the analysis and assumptions used; the values used for inputs to the USEPA Spreadsheets for Environmental Footprint Analysis (SFEA) Version 3.0 were not provided. As a result, there is no way to evaluate the appropriateness of this analysis. The potential use of pond liner materials or mine waste to build the sludge repository should not be allowed as these are acid-generating materials and can react with the sludge. It appears that there is a large amount of both refined and unrefined materials used on-site included in this analysis and the details need to be provided for evaluation. Water Board staff request to have the input files provided for evaluation in addition to all assumptions made for this evaluation.

86) The largest issue with the SM-2 option is the transportation of sludge off-site to a hazardous waste facility in Beatty Nevada. The use of electric big rig trucks should also be analyzed for off-site transportation of sludge which would significantly reduce the environmental footprint.

Appendix L Estimated Risk Reduction from Early Final Remedial Action Remedy Implementation

87) See attached memo from Amanda Palumbo, PhD, OEHHA for detailed comments on the risk reduction assessment. (Attachment C)

88) Running the risk analysis during average flow is not the reasonable worst case scenario. The risk should be calculated during low flows in the creeks and average flow from the new treatment plant to estimate the highest risk.

89) It is not clear why AR is using SW-27 as the background location for this action, as it is not a background location. Data from Station 1 and SW-1 are the appropriate data to use as background. SW-27 being downgradient from the mine has the potential for past impacts from mine sediment discharges which have not been fully characterized. Water Board staff have commented on the lack of characterization of sediment chemical characteristics and sediment transport evaluations, both of which are required by the original USEPA Scope of Work attached to the Order to AR and have the potential to impact water quality at SW-27.

90) Page 1 and 2 – The evaluation for risk reduction does not seem appropriate and has some flaws in the analysis. First, the No Action alternative, alternative AD-1 does not correctly represent what remedial actions are on-going at Leviathan mine. If no action was taken as part of this proposed project, AMD would still continue to be captured and treated year-round for the Adit, Pit Under Drain and Aspen Seep, and seasonal capture and treatment would continue for the Channel Under Drain and Delta Seep. The No Action alternative should represent no further action beyond what is required and is being done today at the site. Second, the risk reduction comparison is conducted for average flow conditions. However, in Appendix F, four different conditions are calculated (low flow, average flow, above average flow, and peak flow). Risk should be evaluated at the conditions representing the highest risk to humans and ecological receptors. During low flow conditions, there are times

when there is zero flow in unimpacted creeks to use as dilution flows for the treated effluent and this should be accounted for in this risk reduction analysis. Third, in addition to evaluating the concentrations at SW-16, SW-27 and SW-29, the concentrations at the point of discharge should be evaluated, prior to any dilution from surface water from unimpacted tributary streams.

91) Page 1, The statement that "The predicted risks are relevant for comparison purposes among the AD-metals concentrations in surface water and do not represent site-specific risk" does not seem accurate. The reasoning for the predicted risks not representing site-specific risk is due to screening levels not being representative of current water use, which is not an adequate justification to disregard drinking water consumption regulatory screening levels.

92) Page 2, first bullet – This section compares the risk reduction of arsenic and discusses that alternative AD-4 is approximately 40% higher than the hypothetical Hazard Quotient (HQ) based on background arsenic concentrations. These "background concentrations" are meant to represent SW-27, which is downstream of the mine site and has been potentially impacted from the mine site. This is not an appropriate approach to background. Rather, this analysis needs to represent areas that have not been impacted by the mine site. Background water quality information has been submitted by Water Board staff for Upper Leviathan Creek, above the mine site.

93) Page 2, and Table L-2 – The statement that "All HQ values for Alternative AD-4 are at least an order of magnitude below 1, indicating insignificant ecological risk to aquatic life" appears to be conclusory and with no supporting information. When comparing the concentrations of "background" to Alternative AD-4, in all cases except for selenium, the concentrations are higher for the alternative AD-4. It appears that due to many of the calculations being hardness-dependent (values that are calculate based on a hardness value), this leads to a large change in Chronic Aquatic Life Criteria. The hardness values need to be selected based on requirements in the SIP.

94) Page 2, and Table L-2 – Water Board staff does not understand how the alternative AD-4 will have lower risk for cadmium, chromium, copper, nickel, and zinc compared to "background" in this evaluation. When looking at the predicted/estimated concentrations, they are greater for every metal except for selenium for alternative AD-4. In addition, Table L-2 should at a minimum have concentration information included for the nine additional metals that do not have Chronic Aquatic Life Criteria.

Attachment B

Recommendations

by the Desert Research Institute on the

Evaluation of Groundwater Conditions, Leviathan Mine, Alpine County, California

S.S Papadopulos & Associates, Inc.

August 19, 2020 and January 11, 2021

General Comments and Recommendations

The report is a mixture of conceptual model, introduction of new ideas not considered in the Amec Foster Wheeler Site Characterization Report Appendix B Groundwater Technical Data Summary Report, and presentation of data collected in 2016 and 2017. 2017 was a record wet precipitation water year in the northern Sierra Nevada. As a conceptual model report, the report does not do a good job of comparing the record wet year impacts with previous average and drought years. Also, the report presents new concepts such as neutralization of mine waste generated acidity by native carbonate minerals, but these new concepts are not well supported with data and in-depth discussion of the processes. If the purpose of the report is to describe the conceptual model of groundwater flow at the site and the transport of mine waste contaminants by groundwater, the report needs more detail and should incorporate data from previous years as are presented in the Amec Foster Wheeler Site Characterization Report Appendix B Groundwater Technical Data Summary Report. It should also address the comments and recommendations presented below.

The main premise of the report is that groundwater only flows through the mine waste and alluvial materials, groundwater only discharges at the five groundwater collection systems and to Leviathan and Aspen creeks, and that mine contamination does not impact groundwater in the fractured volcanic and sedimentary bedrock. Page ES-4 states “There is no evidence of the migration of mine-influenced groundwater in the bedrock beyond the boundaries of the Site.”

Review of the groundwater report and data from the site indicate that the validity of this conclusion has not been demonstrated based upon:

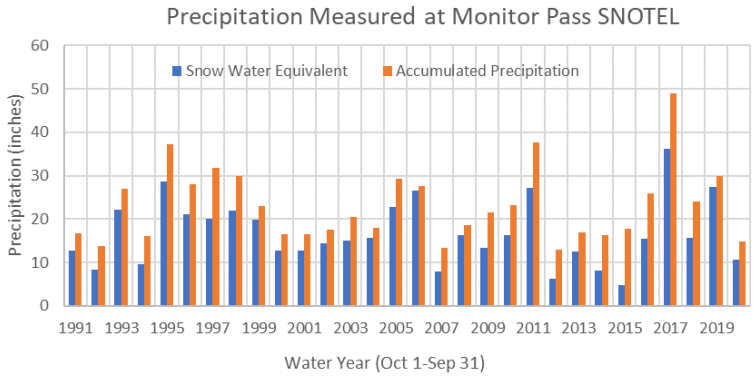
- Insufficient number of downgradient bedrock wells
    - Only 2 bedrock wells downgradient of mine waste in the Leviathan Creek watershed (PZ-07 and MW-41)
    - Only 2 bedrock wells downgradient of wine waste in the Aspen Creek watershed (MW-44 and MW-42: high sulfate concentrations in MW-44 are discounted because of anomalous water levels and MW-42 has pH 10 suggesting poor well construction)
    - Only 1 bedrock well downgradient of the confluence of Leviathan and Aspen creeks (MW-50)
- Vertical downward gradients in nested wells where the deepest wells are in the fractured bedrock
- Water-level fluctuations in bedrock wells that correlate with spring snow melt and groundwater recharge
- Slug-test results in bedrock wells with hydraulic conductivities indicative of groundwater flow
- Seasonal and annual changes in sulfate concentrations in bedrock wells consistent with groundwater recharge

Main Comment

- *Water-levels contours are only constructed for the record wettest water year in the northern Sierra Nevada (2017). How these relate to normal (or average) years, and/or drought conditions is not examined. Report is narrow in its climatic scope and does not address unusually dry and wet years.*

Recommendations

- Below-normal precipitation (drought) years occurred from 2012 through 2015 and approximately average years (22.7 inches Monitor Pass SNOTEL site Figure 1 Papadopulos report) in 2010 and 2016. Water-level contour plots for baseflow conditions (Oct-Dec) should be presented for below normal, average, and record years so they can be easily compared.
- Spring-time snowmelt results in infiltration, groundwater recharge, and increases in water-levels in wells. Changes in water-level contours for below normal, average, and record years should be presented along with baseflow condition contours (Oct-Dec) so they can be easily compared.
- Water-level contours should be plotted independently for unconsolidated and bedrock aquifers. Additionally, the potential for flow through the basalt outcrop should be explored rather than simply truncating contours at that location.
- As shown in the chart below, some of the lowest recorded values of snow water equivalent occurred between 2012 and 2015 (Data downloaded from: https://wcc.sc.egov.usda.gov/nwcc/site?sitenum=633). These years are widely referred to as "drought" years both in the literature and by inhabitants of the area. In 2017, the highest values for SWE and accumulated precipitation were recorded. Extreme events are known to affect groundwater flow regimes, sometimes persisting for years. The report focuses on the year of extremely high precipitation and does not acknowledge the previous drought. The Monitor Pass SNOTEL station collects snow water equivalent, snow depth, accumulated precipitation, and air temperature. As much as possible, 30-year averages should be analyzed to gain a better understanding of: averages, max, mean, extreme values, etc. of climate surrounding the site. Climatologists work in intervals of 30-year averages; using this interval allows for comparisons with other sites and studies.



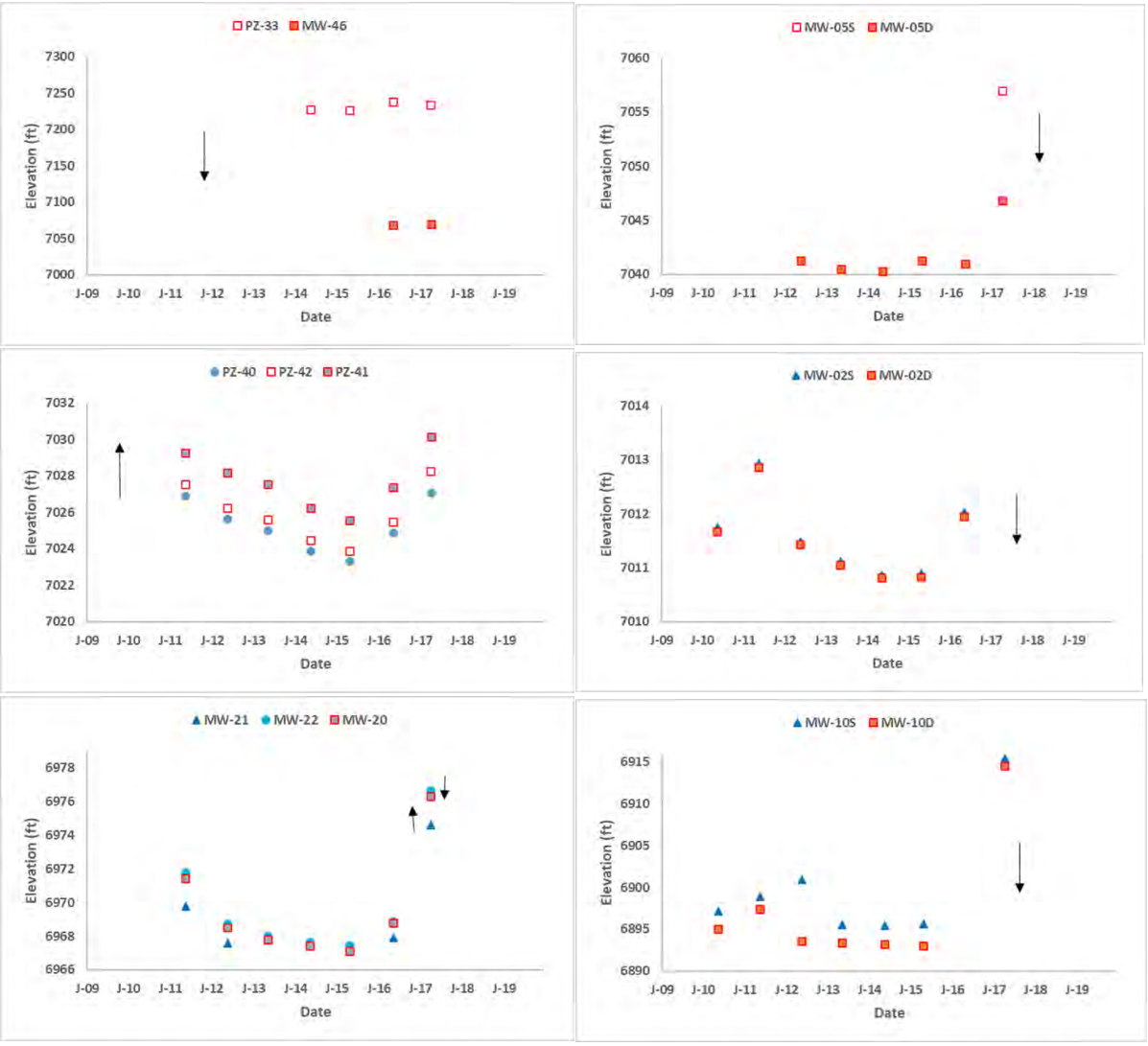
Main Comment

- *Most nested wells that penetrate the bedrock show downward vertical gradients indicating groundwater recharge to the bedrock aquifer. Recharge to the bedrock aquifer indicates groundwater flow in the aquifer.*

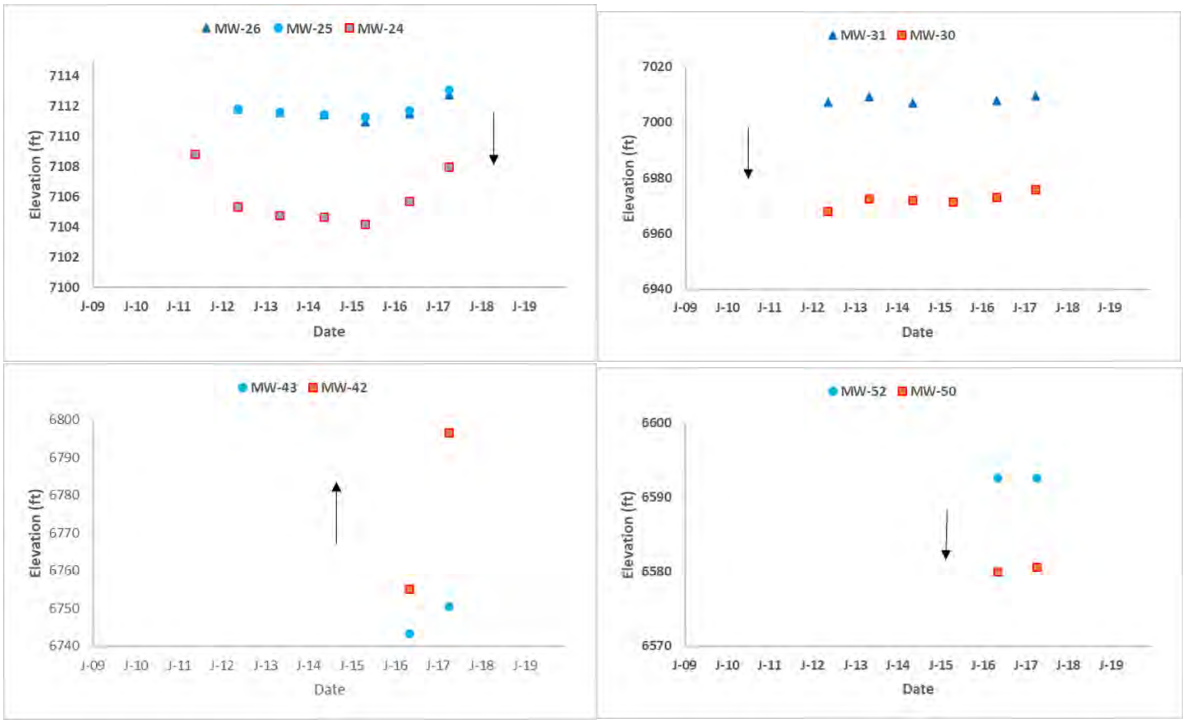
Supporting Evidence

- Vertical gradients in nested wells

Leviathan Creek Watershed

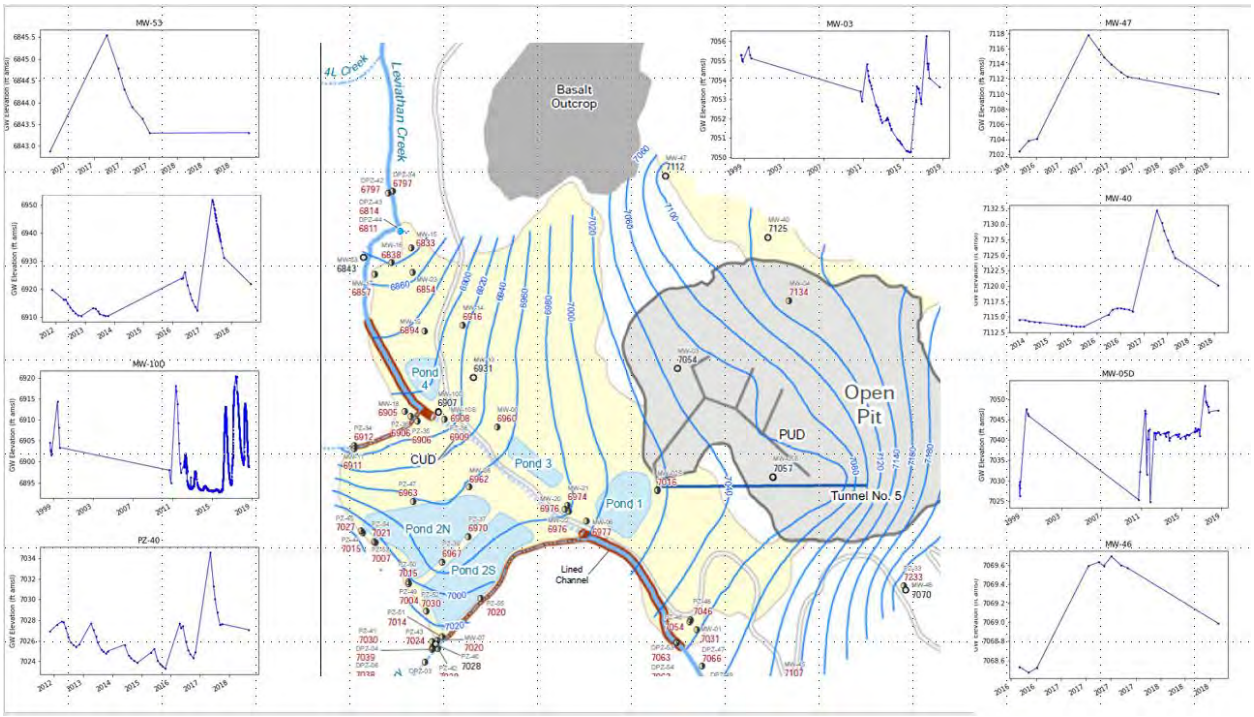


Aspen Creek Watershed

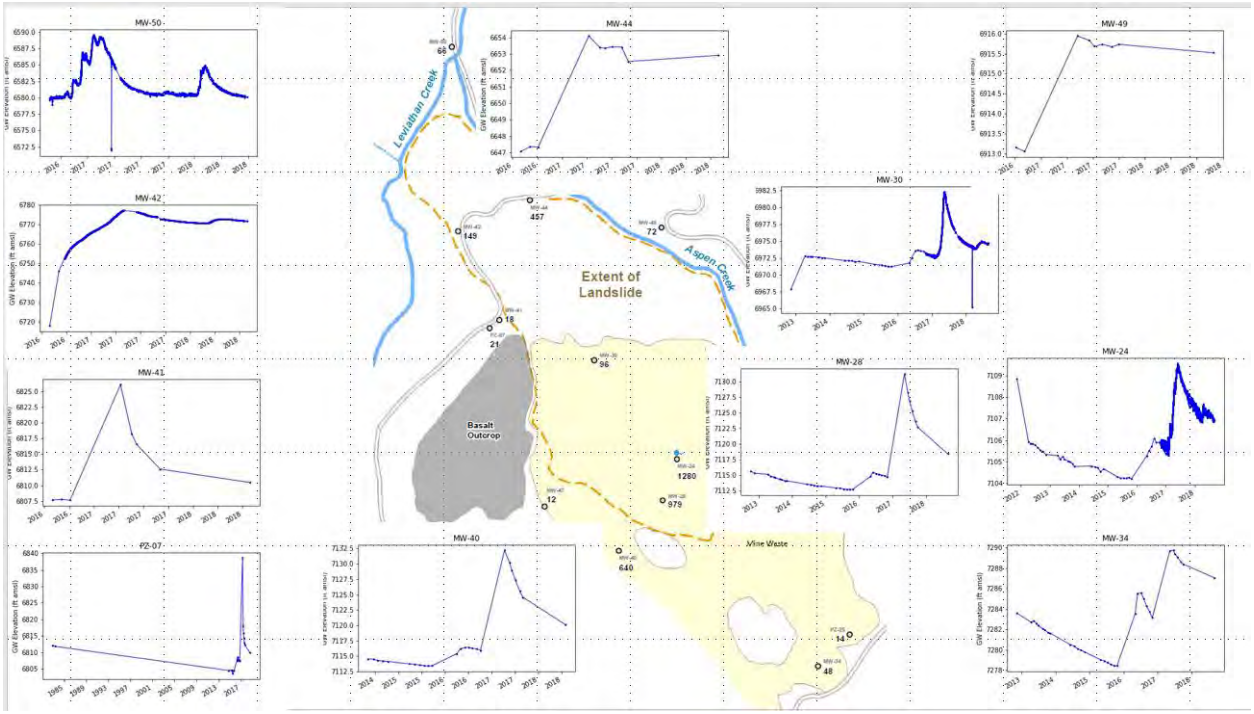


- Water-level Fluctuations in Bedrock Wells

Leviathan Creek Watershed



Aspen Creek Watershed



Recommendations

- As with the water-level contours, water-level changes over time in all nested well pairs should be presented so that vertical gradient directions can be compared for seasonal and annual variations. Plots for nested wells similar to the Amec Foster Wheeler Site Characterization Report Appendix B Groundwater Technical Data Summary Report figures 6-20 through 6-25 should be updated with 2017 record wet year data.
- It appears that groundwater flow is occurring through the fractured bedrock as evidenced by the nested well hydrographs. In addition to the downward gradient seen at these wells, a rapid response to water level changes is seen in the nested bedrock wells (Plates 7a and 8a). This should be discussed.

Main Comment

- *The bedrock aquifer is referred to as a "regional aquifer" but should be considered a local aquifer in a recharge zone.*

Recommendations

- The different aquifers are poorly defined. The definitions of the different aquifers as described in the Amec Foster Wheeler Site Characterization Report Appendix B Groundwater Technical Data Summary Report should be used.
  - The regional aquifer (referred to a regional flow) is defined as the deep metamorphic and granitic rocks between (the crest of) the Sierra Nevada and the lowland regions where groundwater flows to the northeast.
  - An intermediate aquifer that includes the Bryant Creek watershed and the east fork of the Carson River watershed. Rocks of this aquifer include Tertiary volcanic and volcanoclastic units (e.g. andesite, latite) with groundwater flowing to the north and northeast into the Carson Valley.
  - The local aquifer that includes Quaternary unconsolidated units and mine related overburden and waste.
- The properties of these different aquifers should be described (hydraulic conductivity from slug tests; fracture and faulting information such as location/orientation and observed mineralization and hydrothermal alteration; and other information as outlined in the 2008 Statement of work).

Main Comment

- *Water budget is based upon poorly supported assumptions and uncertainty is not quantified.*

Recommendations

- The water budget presented in Table 9 was calculated for an average year and a wet year. It appears that rather than averaging the data to get an average year, they picked a year that looked average, and used data for that year. For a wet year, it appears that they used the record wet year of 2017. An average year should be based on a 30-yr moving average, meaning that for the current year (2020), mean precipitation values from 1990 to 2019 would be used. A wet year should not be the wettest year on record.
- The reason for the values chosen for each parameter in the budget (i.e., precipitation, flow out the Adit, flow from the PUD, recharge, etc.) are not presented very carefully. Presumably, they are the best estimates for the average and wet (2017) years. These should also be based on 30-year averages as well, if they exist. The standard deviation for each parameter should also be determined as this would help develop uncertainty for the value of each parameter. To determine an estimate of uncertainty in the budget, standard error propagation techniques should be used, where calculations include plus/minus values for each parameter.
- An equation for water balance is not presented, although it can be inferred from the parameters presented in Table 9. Presenting a formal water-budget equation with a figure depicting the boundaries of the portion of the aquifers being balanced should be included.
- An important assumption not stated by the authors is that the hydrologic budget is steady state from year to year. This means that there is no change in groundwater storage between years. The importance of this assumption is not clearly explained, but a steady state assumption would result in no change in average base flow in October and November, just prior to the arrival of late fall and early winter storms. The large variations in flow rates indicate that annual changes in storage of groundwater should be considered. For example, figures 3b, 7, and 8 correlate WESD at Monitor Pass with average fall baseflow rates at SW-15, surface-water runoff at the regraded pit, and SW-12 (Creek 4L). All three figures show a negative y-intercept suggesting that there is a threshold WESD for which there is no baseflow the following October. This begs the question: what happens to the remaining WESD if it does not contribute to baseflow? The value of the x-intercept suggests that it is stored somewhere, possibly in the unsaturated zone. At these three locations, the plots show that baseflow becomes zero even though there was appreciable WESD that year. If there is no baseflow in the fall, but there was precipitation as WESD the previous winter, then what happened to the excess WESD that did not contribute to baseflow? The x-intercept values for the three locations suggest that there are 7 inches of water stored at SW-15, 5 inches in the Pit, and 10 inches at SW-12. If so, then this water would become available in the following year. In anticipation of the statement that the unaccounted-for water (the x-intercept value) simply evaporated, that is likely not the case, as all of the evaporation is accounted for in the slope of the regression (which depicts the ratio of recharge to

precipitation). If the unaccounted-for water is stored in the unsaturated zone, then this should be considered in the hydrologic balance as temporal storage.

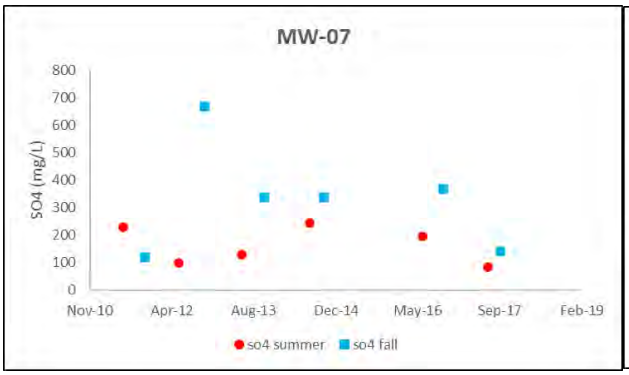
- Some values of the parameters used are suspect.
  - In particular, the "infiltration" estimate is over 60 percent of the precipitation, which is an extremely high value for this type of setting. This value should be compared to other similar areas found in the literature.
  - The authors use the term infiltration in the same sense as groundwater recharge, which is water that infiltrates and reaches the saturated zone and can, therefore, be included as a direct increase in the amount of groundwater. Infiltration, on the other hand, is water that flows downward from the land surface toward the saturated zone but does not necessarily reach it. It, therefore, may or may not be recharge (e.g., for the following year), as it could be evaporated from the unsaturated zone or transpired through plants. The difference between infiltration and recharge should be discussed.
  - The authors admit that ET and runoff are calculated as one single term, and it seems that these values may have been used to balance the budget. This may not be correct, and it is possible that a storage term may help in the water balance.
- The water budget is constructed only for water in the mine waste and does not consider groundwater flow in the underlying volcanic and volcaniclastic geologic units. These units are defined as the intermediate flow system (aquifer) in the Amec Foster Wheeler Site Characterization Report Appendix B Groundwater Technical Data Summary Report (Section 2.2.5). The water budget should address groundwater flow in this aquifer in conjunction with groundwater flow in the mine waste.
- The upgradient flow rate, which is estimated to be between 13 and 21 gpm (Table 9, pg 55, August 19, 2020; Table 10, pg 56, January 22, 2021), is only for flow into the mine waste and is based upon the assumption that all the groundwater in the mine waste is captured by the locations where flow is measured (Adit, PUD, CUD, Delta Seep, Aspen Seep). If there is uncaptured (not measured) flow, then the upgradient flow into the water budget is underestimated. Other methods to estimate upgradient flow into the mine waste should be used and estimates compared with the regression analysis used in the current version of the water budget.
- Additional work should be conducted to assess groundwater flow in the intermediate groundwater flow system (aquifer) and its connection with the overlying mine waste. The intermediate aquifer is described in the Amec Foster Wheeler Site Characterization Report Appendix B Groundwater Technical Data Summary Report (Section 2.2.5). This aquifer includes Tertiary volcanic and volcanoclastic units, which underlie the local aquifer of mine waste and naturally occurring alluvial materials.

Main Comment

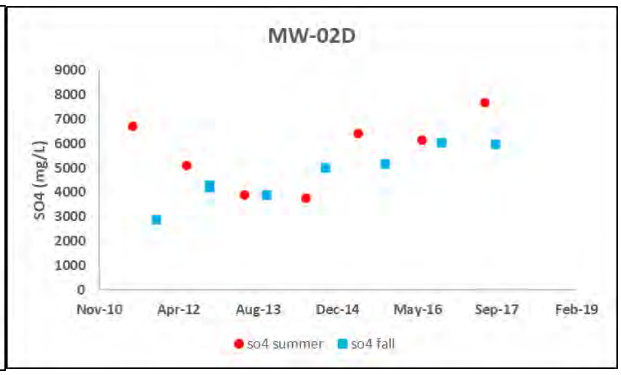
- *Variation in acid mine drainage contaminants of concern concentrations (and/or loading) between record wettest water year and normal (or average) year, and/or drought conditions is not presented. The record wet year in 2017 likely results in dilution of contaminants.* (Note this is the opposite of what happens in some cases, see below).

Supporting Evidence

Leviathan Creek Watershed

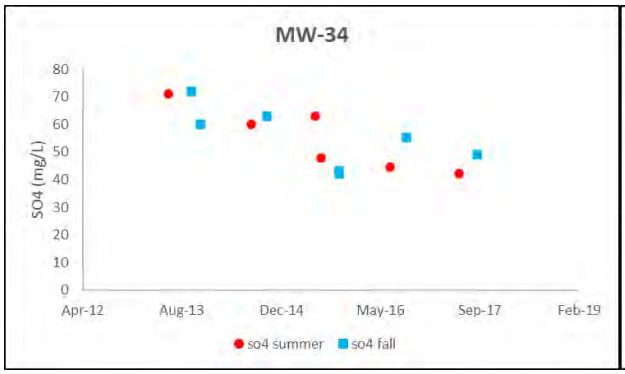


Above Pond 2S

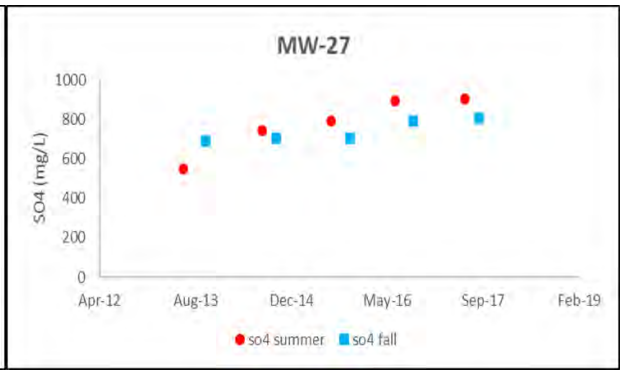


Next to Adit

Aspen Creek Watershed



Above Landslide



Within Landslide

Recommendations

- In the monitoring wells where data are available before the drought years (2010-2011), the drought years (2012-2015), the average precipitation year of 2016, and then the record wet year 2017, upgradient wells unaffected by mine waste show a decrease in concentration of sulfate from the drought years to the wet years (e.g., MW-07 and MW-34), whereas wells affected by mine waste show the opposite, increases in sulfate from the drought years to the wet years. Upgradient wells unaffected by mine waste have higher sulfate concentrations during the late summer/fall sampling events, whereas wells affected by mine waste have higher concentrations during the spring/early summer sampling events. In wells and piezometers where these large differences are

observed, it should be discussed, and hypotheses presented as to why this occurs. In the current report, they only show average concentrations for 2016 and 2017 samples and do not discuss the large differences between drought years and the record wet year.

- How these large differences in concentrations in sulfate, pH values, arsenic, and other metals affect the cumulative mass of contaminants captured (and not captured) in the ponds and treatment structures, and that might be entering the groundwater and not captured, should be discussed.

Main Comment

- *Derivation of criteria for identifying acidic mine-influenced groundwater and mine-influenced groundwater is not presented.*

Recommendations

- Acidic mine-influenced groundwater is defined as sulfate concentrations greater than 200 mg/L and pH less than or equal to 6.5. How these criteria were determined needs to be presented. 200 mg/L sulfate for background native groundwater unaffected by localized mineralization appears to be too high.
- Mine-influenced groundwater is defined as sulfate concentrations greater than 200 mg/L and pH greater than 6.5. How this was determined needs to be presented. That is, for example, was it a quantitative analysis using statistics evaluating pH measurements or was it a qualitative determination because it's close to neutral pH?
- In the revised report of January 11, 2021, Figure 22 and the accompanying paragraph are used to explain the selection of 200 mg/L as the criterion for defining the extent of mine-influenced groundwater. The selection, application of, and techniques used to develop this criterion is not described well. More explanation of the technique, the wells used, the time period of the data used, and the data set selected is needed.
- As described above, sulfate concentrations vary seasonally and annually. The average precipitation year 2016 and record wet year 2017 show elevated sulfate concentrations relative to the drought years from 2012 to 2015. Data from all available years should be used to develop the criteria for mine-influenced groundwater, assuming that metal and oxyanion concentrations behave similarly. For example, Figure 23 in the January 11, 2021 report only use data from 2016 and 2017 to define elevated concentrations of mine-related constituents of interest relative to acidic mine-influenced groundwater.
- A clear set of criteria should be developed for included or excluded wells to determine acidic mine-influenced and mine-influenced groundwater.

Main Comment

- *Occurrence of carbonate minerals that neutralize acid generated by oxidation of mine waste is not well documented.*

Recommendations

- The Papadopulos report leans heavily on the occurrence of calcite (carbonate minerals) to explain neutralization of acidic groundwater. However, the Amec Site Characterization report and Appendix B Groundwater Technical Data Summary Report do not mention calcite or neutralization of acidic groundwater by carbonate minerals.
- The Papadopulos report refers to Sciacca (1984) and Herbst and Sciacca (1982) mentioning the occurrence of calcite in monitoring well borings, healed fractures filled with calcite in andesite, and fracture and pore-filling cement in the lahar and sandstone. The report specially refers to monitoring wells 42 and 50, however, the logs of these wells, and examples of the presence of calcite are not presented.
- The report needs to explore and document this hypothesis, and the extent of the occurrence of calcite, in more detail. Each monitoring well log and the geologic material that the calcite was observed in should be listed. The locations and extent of observed calcite in fractures and faults should be shown on maps. The amount of carbonate material available for neutralization of acid mine drainage should be estimated along with an estimate of whether there is sufficient carbonate material available to neutralize acid mine drainage. Maps where the neutralization is occurring should be shown.
- The assertion that there is little or no flow through the bedrock underlying the site contradicts the idea that mine-generated acidity is neutralized by carbonate minerals in fractures and pore-filling cement. For the acidity to be neutralized by the calcite in the bedrock, the acidity from the overlying mine waste would need to flow downward into the bedrock and flow through the fractures and faults to be neutralized by the calcite fracture linings.

Main Comment

- *The extent of the ore body, and the effects of water-rock reactions in the mineralized zone of the ore body in the bedrock aquifer, are not discussed.*

Recommendations

- The extent of the ore body is only shown on figures E-2 and E-5. The extent of the ore body should be included on numerous figures including EX-1, EX-2, EX-3, 2, 3a, 3b, 4, 5, 5a, 5b, 6, 7, 12, 13, 14, 21, 22, 23, 24, E-1, E-9, E-11, E-14, E-17, E-19, F-1, F-2, K-1a, K-2a, K-3a, K-4a, K-5a, K-6a, K-7a, and K-8a, so that the relationship of the ore body to wells and piezometers and to other information such as water-level contours and pH, and concentrations of sulfate, arsenic, and metals can be examined.
- There is minimal discussion about groundwater interaction with the ore body and groundwater movement away from the ore body other than discussions about Tunnel 5 (Adit) and PUD. Groundwater quality/contamination in the ore body in regard to the monitoring wells within the pit is not discussed other than presenting sulfate concentration and pH on several plates.

Main Comment

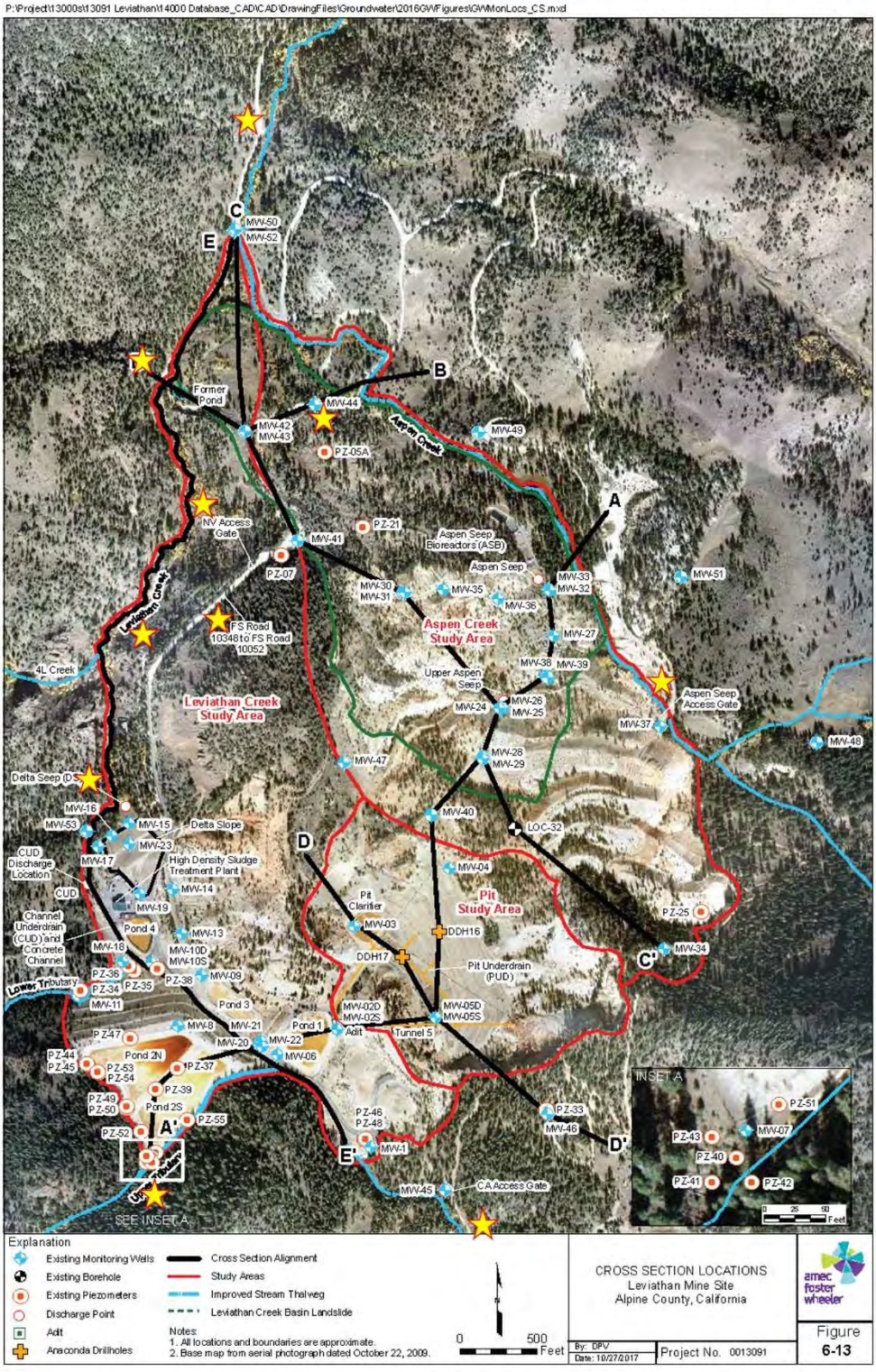
- *There are not enough wells in the bedrock aquifer, both upgradient and downgradient of the mine impacted areas, to characterize the flow and transport of mine contaminants considering the fractured nature of the aquifer.*

Recommendations

- There are approximately 34 bedrock wells in the study area, although it's hard to know exactly how many in total, even when looking at both Papadopulus and Amec reports. Recommend a table (or Appendix) with list of bedrock wells and the geologic unit they are completed in.
- Upgradient bedrock wells Leviathan Creek watershed:
  - MW-46 has elevated sulfate and low pH indicative of being mine influenced. Cross-section Figure 6-17 from Amec Foster Wheeler Site Characterization Report Appendix B Groundwater Technical Data Summary Report shows MW-46 being completed in the ore body within andesite. This well is not a good well to represent upgradient bedrock groundwater not influenced by the mine.
  - PZ-33 next to MW-46, but at a shallower depth, has sulfate of 123 mg/L (2017) and pH 5.5 (2017) indicative of being mine influenced. Cross-section Figure 6-17 Amec Appendix B shows this piezometer is completed in bedrock above the ore body in andesite, but Papodopulos report shows it being in unconsolidated material. This well is possibly a good well to represent upgradient bedrock groundwater.
  - PZ-41 and PZ-42 just above pond 2S in the Upper Tributary are in bedrock, breccia and latite, respectively, according to Cross-section Figure 6-17 Amec Appendix B, but the Papodopulos report does not show any water-quality data in 2017 for these piezometers. They may be good upgradient bedrock groundwater sample locations if representative samples can be collected.
- Upgradient bedrock wells Aspen Creek watershed:
  - MW-34 has high pH (8.3, 2017) and low sulfate (48 mg/L, 2017) suggesting it is a good well to represent upgradient bedrock groundwater.
  - PZ-25, close to MW-34, but located within the mine disturbed area, has low pH (4.1, 2017), but also low sulfate (14 mg/L, 2017). The pH suggests that this well in not a good well to represent upgradient bedrock groundwater.
- Downgradient bedrock wells Leviathan Creek watershed:
  - There are no downgradient bedrock wells in the Leviathan Creek watershed that are not impacted by mining except maybe MW-50.
  - There is a lack of bedrock wells below the Delta Seep down to the confluence of Leviathan and Aspen creeks.
  - There are no bedrock wells downstream of MW-50.
- Downgradient bedrock wells Aspen Creek watershed:
  - There are only three bedrocks downgradient of the mine waste and landslide in the Aspen Creek watershed, MW-44, MW-42, and MW-50.

- MW-42 has evaluated pH (10.5, 2017) indicative of cement contamination from a bad well completion and no direct contact between the well screen and groundwater in the aquifer.
- MW-44 has high pH (8.3, 2017), but elevated sulfate (457 mg/L, 2017) suggesting some impact from upgradient mine waste.
- MW-50 may not (or could be) be impacted by upgradient mine waste.

- It may not be economically possible at this point of the project to drill more wells, but more observations points in the bedrock are needed, particularly downgradient, and are recommended.
- Locations for additional bedrock wells include:
  - 2 more upgradient bedrock wells
  - 3 bedrock wells along Leviathan Creek between the Delta Seep and MW50/52
  - 1 bedrock well northwest of the basalt outcrop
  - 1 bedrock well downgradient of MW 50/52
  - 1 bedrock well along Aspen Creek
  - 1 bedrock well between MW-44 and MW 42/43 at the toe of the landslide
    - MW 42/43 has pH 10.5 suggesting poorly completed well that is not in contact with bedrock
    - Papadopulos report claims that MW 44 has anomalous water levels, so the high sulfate is not to be trusted
  - 1 bedrock well downgradient of MW-53



Yellow stars are approximate locations of recommended additional bedrock wells.

Attachment C

MEMORANDUM

TO: Cathe Pool, PE
Senior Water Resources Control Engineer Los Angeles
Lahontan Regional Water Quality Control Board
2501 Lake Tahoe Boulevard
South Lake Tahoe, CA 96150

FROM: Amanda Palumbo, Ph.D.
Staff Toxicologist
Air and Site Assessment and Climate Indicators Branch
Office of Environmental Health Hazard Assessment

DATE: January 12, 2022

SUBJECT: REVIEW OF FOCUSED FEASIBILITY STUDY FOR OU-1 MINE-INFLUENCED GROUNDWATER AND METALS IN SURFACE WATER, LEVIATHAN MINE SITE, ALPINE COUNTY, CALIFORNIA, AUGUST 6, 2021
SWRCB # R6-20-001 **OEHHA # 880481-02**

Scope of Review

The Lahontan Regional Water Quality Control Board (Lahontan Water Board) requested that the Office of Environmental Health Hazard Assessment (OEHHA) review an assessment of risk reduction from a proposed Early Final Remedial Action. The risk assessment is for human and aquatic life exposure to inorganic chemicals in surface waters.

Document Reviewed

Focused Feasibility Study for OU-1 Mine-Influenced Groundwater and Metals in Surface Water, Leviathan Mine Site, Alpine County, California (FFS Report), dated August 6, 2021, prepared by Wood Environment & Infrastructure Solutions, Inc.(Wood).

This review focused on:

Appendix L: Estimated Risk Reduction from Early Final Remedial Action Remedy Implementation.

Limitations of Review

This review did not include checking the calculations of the predicted concentrations of inorganic chemicals in Bryant Creek, which is beyond the expertise of OEHHA. The estimated concentrations in the creek water were assumed to be correct for this review, and OEHHA defers to the Lahontan Water Board on their validity.

Site Description and Background

The Leviathan Mine is an open-pit sulfur and copper mine, in the Sierra Nevada mountains, 24 miles southeast of Lake Tahoe. Mining ceased in 1962, and acid mine drainage and metals continue to pollute nearby creeks. These creeks pass through lands used by the Washoe Tribe and as wildlife habitat. The affected creeks cross the border into Nevada, draining into the east fork of the Carson River. The Lahontan Water Board and Atlantic Richfield Company (ARCO) currently operate water treatment facilities on the site to reduce impacts from the acid mine drainage.

Site Characterization

The concentrations of inorganic chemicals in soil, groundwater, surface water, and other media have been documented in the Site Characterization Report that OEHHA previously reviewed in a memorandum dated May 16, 2018.

Chemicals of potential concern (COPCs)

COPCs are inorganic chemicals from acid mine drainage, which are referred to as metals in the FFS Report and subsequent sections of this memorandum, although the COPCs include some non-metals, such as arsenic and selenium. See Table 1 for a list.

Early Final Remedial Action

Recently, an Early Final Remedial Action has been proposed to address metals in acid mine drainage in groundwater and surface water in the Leviathan Creek watershed and downstream surface water in Bryant Creek. The FFS Report evaluates the Early Final Remedial Action proposal. Four remedial alternatives for metals in acid drainage were developed for detailed evaluation. They are, as described in the FFS report:

- Alternative AD-1: No Action. Acid drainage would not be captured or treated, existing remediation infrastructure would not be operated or maintained, discharges of acid drainage to surface water would not be controlled, and exposures to groundwater and surface water would not be controlled.
    - OEHHA notes that currently there is treatment of the acid drainage, although some discharges to Leviathan Creek go untreated in winter, so this No Action Alternative does not represent existing conditions. This

No Action Alternative is used in the FFS Report for comparison in risk calculations to illustrate risk reduction of the Recommended Alternative. This is misleading, since the No Action Alternative does not represent existing conditions.

- Alternative AD-2: Reduced Acid Drainage Storage, Centralized Treatment with High Density Sludge (HDS). This alternative would decommission two storage ponds, thereby reducing acid drainage storage capacity.
- Alternative AD-3: Status Quo Acid Drainage Storage, Centralized Treatment with HDS. This alternative would use the five existing acid drainage storage ponds with no modifications to the current configuration or storage capacity.
- Alternative AD-4: Recommended Alternative: Increased Acid Drainage Storage, Centralized Treatment with HDS. This alternative would expand the acid drainage storage capacity by deepening Pond 2S.

Alternatives AD-2 through AD-4 include year-round capture, conveyance, and storage of acid drainage, a centralized HDS-treatment plant, and other elements that are not currently at the site.

Additionally the FFS Report describes two alternatives for managing water treatment sludge were developed for evaluation.

The FFS Report states the remedial action objectives, which describe exposures of concern. However, some routes of exposure are omitted. The contaminants in the creek also indirectly affect terrestrial plants and animals, and there may be indirect human exposures. These exposure routes should at least be included in the baseline risk assessment.

Risk Assessment

Wood estimated the risk reduction that would result from the Recommended Alternative in the FFS. The reduction in risk was calculated by estimating the risk for creek waters for the Recommended Alternative (AD-4) and comparing the results to risk calculated for the No Action Alternative (AD-1). Surface-water acid drainage metal concentrations under average flow conditions were estimated for Alternatives AD-1 and AD-4 at location SW-27, below the confluence of Leviathan and Mountaineer creeks. This location is a little more than 2 miles downstream of the location of the HDS effluent discharge, over a mile outside the site boundary, and incorporates significant dilution from other creeks. The risk assessment leaves about 1 mile of creek outside the property boundary with unknown risk and a little over a mile of the creek on the site with unknown risk.

The metal concentrations at SW-27 are based on several estimated parameters, including the flow regimes in the creeks, the metal concentrations in HDS effluent, and the HDS effluent discharge flow rates. Those estimates and calculations were not evaluated by OEHHA as part of this review. However, the uncertainties in those estimates (not quantified in the FFS Report) would carry over to the estimates of health and ecological risk.

Background Concentrations

It is not clear what data was used as "background" concentrations in the risk calculations in Appendix L. Background should be upstream concentrations that are not impacted by site contamination. In Appendix L there are a couple of general statements on background, such as "risks contributed by tributary streams" but it is not clear what is included. In the footnote to Table L-2 it says that the background is "Estimated concentration at Station SW-27", which seems it could include the current treated acid drainage discharge. Background concentrations should not include contaminants from the site.

In the main report, there is a narrative description that seems to define background:

> "Watersheds that provide streamflow for the assimilation of treated effluent include Leviathan Creek upstream of the site, major perennial tributaries downstream of the site such as Aspen, Mountaineer and Doud creeks, and various ephemeral tributaries including 4L and Barney Riley creeks. Surface-water quality in these streams contribute varying loads of naturally occurring chemical constituents and collectively represent the relevant background surface-water quality".

It is not clear if this is the same background as in Appendix L.

Because risk was assessed only for a far downstream location after tributaries mix with Leviathan Creek, the relevant background concentrations for Leviathan creek were not used in the risk calculations. The Lahontan Water Board has provided background concentrations for Leviathan Creek that also serve as water quality objectives, and these would be the relevant background concentrations to use as comparison for risks to Leviathan Creek upstream of the tributaries.

Cancer Risk and Hazard calculations

OEHHA reviewed the calculations of cancer risk and hazard for human health and the hazard calculations for ecological health. First, OEHHA checked that the screening levels and criteria used to assess risk and hazard were correct. The tap water screening levels from Department of Toxic Substances Control Note 3 (DTSC 2020) and US EPA's Regional Screening levels (US EPA 2021a) were correct. The aquatic life criteria from the California Toxic Rule (40 CFR §131) and US EPA's National Ambient

Water Quality Criteria (US EPA 2021b) were correct. OEHHA also checked the calculations of any criteria that are dependent on hardness, pH, and dissolved organic carbon (DOC) and found those were correct.

The only exception for the aquatic life criteria was that silver and chromium were not included in the aquatic life assessment, for reason that were not clear. OEHHA calculated hazard quotients for these metals based on current concentrations at SW-27 from the Site Characterization Report and found them to have relatively low hazard quotients (both hazard quotients were less than 0.04). From this information, these criteria seem unlikely to have a significant influence on the conclusions.

Then, OEHHA checked the calculations for the hazard quotients and cancer risk, and OEHHA obtained the same results as Wood. The hazard quotients for each chemical were summed to calculate the cumulative hazard index, as appropriate, and OEHHA checked the cumulative estimates. In Table L-2, Aquatic Receptors Risk Reduction Comparison of the Report, there is a minor error in the calculations of total hazard index. OEHHA's result from summing the hazard quotients for the Recommended Alternative in Table L2 of the FFS Report was 1.5 not 2.1.

For human health, the resulting hazard index of 47 for the Recommended Alternative in the FFS Report is clearly over the generally acceptable threshold of 1. The cancer risk estimate was 4E-4, resulting from arsenic, the only carcinogenic contaminant at the site. This risk estimate is over the high end of the risk management range, indicating that the risk should be addressed unless it can be shown to be due to background levels of arsenic.

The FFS report states these risk and hazard estimates are likely higher than most people may experience because they are derived from the tap water screening levels. OEHHA agrees that these screening levels are very protective since they are based on assumed domestic use of water, including ingestion from drinking (2.5 L/d for an adult), inhalation of volatile chemicals generated during household use (e.g., showering, dish washing), and dermal exposure during household use, for 350 days per year (DTSC 2020). However, it is not clear to OEHHA how much Washoe tribe members and other people in the area actually use the water, nor is the risk to those people clear.

The hazard index for ecological effects for the Recommended Alternative, in the FFS Report was 2.1, which is over the generally acceptable threshold of 1. Also, the proposal in the FFS Report leaves a long stretch of Leviathan and Bryant creeks with elevated ecological (and human health) hazard. The FFS report only assesses the hazard at one location over 2 miles downstream from the point of discharge, and a little over 1 mile beyond the property boundary. Hazard estimates were not derived for those 2 miles of creek between the point of discharge and SW-27. The hazard would presumably be higher closer to the point of the discharge than at SW-27. The ecological

hazard index for untreated effluent was 517, but the hazard at the point of the discharge of the treated effluent is unknown.

To understand the impacts of proposed actions, the risk should be assessed for a location at the point of discharge and a couple of locations downstream, for example SW-16 and SW-27. Risk at the point of discharge should be compared to the risk for upstream, un-impacted water of Upper Leviathan Creek (background). This would show how elevated the hazard is close to the point of discharge. These risk estimates should be included in the FFS report or the baseline ecological risk assessment so that all stakeholders are clear on the risks at the site and off-site, and the changes in risk resulting from potential remedial actions. The FFS Report mentions that institutional controls will be used to address the human health hazard. Institutional controls will not protect wildlife.

OEHHA attempted to estimate the ecological hazard index risk for the HDS effluent and SW-16. (The Lahontan Water Board has explained that in some dry years, there is no dilution from Upper Leviathan Creeks or tributaries and the only water in the creek will be the HDS effluent.) However, the data in Table 6-2 of the report has some constituents presented as dissolved concentrations and some as total concentrations, with no complete data set for either form. Because of this the data cannot be used for human or ecological risk calculations.

Also, the predicted metals concentrations downstream of the HDS effluent in Table 6-2 of the FFS Report, for Average Flow, at SW-27 do not match those in Table L-1 and L-2 for the Recommended Alternative at SW-27, even when comparing metals in the corresponding form (total or dissolved). It seems that these should be the same. It is not clear why these values are different.

Need for Waivers

The FFS Report states that waivers will be needed at least for aluminum, arsenic, manganese and thallium, because the Applicable or Relevant and Appropriate Requirements (ARARs, i.e, Maximum Contaminant Levels [MCLs] or criteria) will not be met. It is not clear if the waivers are being proposed to address human health or ecological concerns, because the basis for these ARARs are not provided. For example, there is no indication of the source of the aluminum ARAR of 470 µg/L in Table 6-2. Table 6-2 presumably has a mixture of human health and ecological ARARs from different sources. This is confusing. OEHHA looked up MCLs for comparison, and the ARARs in Table 6-2 for arsenic, manganese, and thallium appear to be MCLs. Overall, it seems that conclusions were made about the need to address human health impacts and not ecological health impacts, and the rationale for dismissing the ecologic impacts is not apparent in the FFS Report.

Comparison to Current Conditions at SW-27

The FFS Report included four alternatives. In the risk assessment portion of the report the Recommended Alternative was compared to the No Action Alternative. However, currently, the acid mine drainage is being treated. Comparing the Recommended Alternative to the No Action Alternative gives an exaggerated view of the benefits of the proposal relative to current conditions. Therefore, OEHHA performed calculations using an estimation of current conditions. An approximation of the average current conditions at sampling location SW-27 was obtained from the Site Characterization Report. The upper confidence limit (UCL) on the mean concentration of total metal concentrations in surface water at SW-27 was found in Table 7-5A of Appendix A of the Site Characterization Report. The UCL on the mean concentration of dissolved metal concentrations in surface water in Reach 2 was found in Table 7-5B of Appendix A of the Site Characterization Report. Reach 2 includes SW-27, and two downstream locations, SW-28 and SW-73, and therefore the dissolved metal concentrations likely somewhat underrepresent current conditions at SW-27. Additionally, OEHHA notes that concerns were raised about inappropriate outlier removal from data sets in the Site Characterization Report, and the data sets have not been reevaluated, so there may be inaccuracies in the data set.

Some of the aquatic life criteria are dependent on hardness, pH, and dissolved organic carbon, so criteria must be calculated specifically for the various alternatives considered. For the current conditions at SW-27, OEHHA used a hardness of 131 mg/L. A value for hardness could not be found in the Site Characterization Report, so OEHHA used the same value Wood used for the Recommended Alternative (131 mg/L), which was close to the average hardness measured at SW-27 of 136 mg/L (data provided by the Lahontan Water Board). The pH of 7.75 was used, based on pH measurements at SW-27 from Figure 6-39B in Appendix A of the Site Characterization Report. The dissolved organic carbon concentration of 1.3 mg/L was used since that value was used by Wood for Background, the No Action Alternative, and the Recommended Alternative.

The resulting metal concentrations for current conditions (data compiled by OEHHA) were lower for twelve metals compared to the predicted concentrations in the Recommended Alternative (Table 1). This is somewhat surprising since it suggests that the Recommended Alternative would not provide better removal of those twelve metals than the current treatment system.

Table 1. Metal Concentrations (total, µg/L) in Bryant Creek (SW-27) and Screening Levels Used to Assess Human Health Risk for Remedial Alternatives

Chemical	Back-ground*	No Action*	Reccom-mended*	Current**	Current compared to Reccom-mended	Tap Water Screening Level
Aluminum	186	9985	284	205	Lower	20000
Antimony	1	0.5	1.2	0.149	Lower	7.8
Arsenic	1.7	389	2.3	3.25	Higher	0.0082 (c), 0.070 (nc)
Barium	39	4.3	38	33.9	Lower	3800
Beryllium	0.23	1.5	0.28	0.0452	Lower	4
Cadmium	0.5	2.2	0.58	0.059	Lower	9.2
Chromium	2.5	107	2.7	0.242	Lower	22000
Cobalt	0.34	71	0.58	4.29	Higher	6
Copper	1.4	94	1.6	2.87	Higher	800
Iron	340	78084	403	670	Higher	14000
Lead	0.5	0.3	0.58	0.0568	Lower	15
Manganese	27	5535	29	245	Higher	430
Mercury	ND	ND	ND	ND	ND	3
Nickel	5	722	5.4	11.5	Higher	220
Selenium	1	1.9	1	0.887	Lower	100
Silver	5	53	4.9	0.016	Lower	94
Thallium	0.46	5	2.5	0.383	Lower	0.2
Vanadium	4.2	122	4.2	2.59	Lower	86
Zinc	10	109	12	7.18	Lower	6000

Table notes: * data from Table L-1 of Appendix L of the FFS Report; ** data compiled by OEHHA from the Site Characterization Report (see text); “ND” indicates not detected; “c” indicates cancer; “nc” indicates noncancer.

For the human health assessment, OEHHA calculated a hazard index for current conditions that was similar to the Recommended Alternative (50 vs. 46; see Table 2a).

Table 2a. Human Health Hazard Estimates for Remedial Alternatives

Chemical	Background	No Action	Recommended	Current
Aluminum	0.009	0.50	0.014	0.010
Antimony	0.13	0.0641	0.15	0.0191
Arsenic	24	5557	33	46
Barium	0.010	0.0011	0.010	0.009
Beryllium	0.058	0.38	0.070	0.011
Cadmium	0.054	0.24	0.063	0.0064
Chromium	0.0001	0.0049	0.0001	0.0000
Cobalt	0.057	11.83	0.10	0.72
Copper	0.0018	0.12	0.0020	0.0036
Iron	0.024	5.6	0.029	0.048
Lead	0.033	0.020	0.039	0.0038
Manganese	0.063	13	0.07	0.57
Mercury	ND	ND	ND	ND
Nickel	0.023	3.28	0.025	0.052
Selenium	0.010	0.019	0.010	0.009
Silver	0.053	0.56	0.052	0.00
Thallium	2.3	25	13	1.9
Vanadium	0.049	1.4	0.049	0.030
Zinc	0.0017	0.018	0.0020	0.0012
Hazard Index (Sum)	**27**	**5619**	**46**	**50**

Table Note: “ND” indicates not detected;

The cancer risk estimate for arsenic was lower for the Recommended Alternative compared to current conditions, by less than an order of magnitude (Table 2b).

Table 2b. Human Health Cancer Risk Estimates for Remedial Alternatives

Chemical	Background	No Action	Recommended	Current
Arsenic	2.1E-04	4.7E-02	2.8E-04	4.0E-04

Table Note: estimates presented in scientific notation, where “E” stands for “exponent”.

For the aquatic life assessment, the metal concentrations are shown alongside the criteria calculated for the specific hardness, pH, and DOC of each alternative, in Table 3. The concentrations of seven metals were lower under current conditions than under the Recommended Alternative. Only arsenic, iron, and nickel were higher in current conditions than in the Recommended Alternative (Table 3). Also, OEHHA found a lower aquatic life hazard index for current conditions compared to the hazard indices for the Recommended Alternative and Background (Table 4). This is because some of the metals that were higher in current conditions, arsenic and nickel, had relatively low hazard quotients. The concentrations of cadmium, copper, lead and zinc, contributed most to the difference in the hazard indices in the alternatives assessed.

Benefit of Year-Round Treatment

The FFS Report does not make the benefits of the Recommended Alternative clear, in reducing risk compared to the current state of the site. However, the risk reduction from year-round treatment (vs. nine months of treatment for some discharges) would be a significant risk reduction. There is discussion on the benefits of year-round treatment in Section 2.2 of the FFS Report, but it is not included in the section of the FFS Report on risk reduction.

Other Comments

A statement on mercury analytical limits on page 30 of the FFS Report is inaccurate: “an ARAR waiver for mercury will be required. This is because the chemical-specific ARAR for mercury of 0.05 µg/L cited in the California Toxics Rule (see Table 4-1) is below the practical quantitation limit provided by analytical laboratories.” Current analytical methods for mercury in water can measure mercury at concentrations below 50 ng/L (0.05 µg/L). The method detection limit (MDL) for US EPA Method 1631, Revision E is 0.2 ng/L when no interferences are present, and the minimum level of quantitation (ML) is 0.5 ng/L (US EPA 2002). For US EPA Method 245.7 the MDL is 1.8 ng/L and the ML is 5.0 ng/L (US EPA 2005).

For complex sites like the Leviathan Mine site, developing a work plan for stakeholder review can be very beneficial, before major reports are developed. In this case, developing a work plan for the FFS Report for stakeholders to review could have helped to vet the main aspects, such as the alternatives that were considered and the locations for which risks were calculated.

Table 3. Metal Concentrations (µg/L) in Bryant Creek (SW-27) and Aquatic Life Criteria Used to Assess Aquatic Life Hazard for Remedial Alternatives

Chemical	Back-ground*	Criteria for Back-ground*	No Action*	Criteria for No Action*	Reccom-mended*	Criteria for Reccom-mended*	Current	Criteria for Current	Current compared to Reccom-mended
Aluminum	186	1300	9985	28	284	1100	205	890	Lower
Antimony	NC	NC	NC	NC	NC	NC	NC	NC	NC
Arsenic	0.73	150	971	150	0.8	150	2.39	150	Higher
Barium	NC	NC	NC	NC	NC	NC	NC	NC	NC
Beryllium	NC	NC	NC	NC	NC	NC	NC	NC	NC
Cadmium	0.22	1.8	1.5	2.4	0.31	2.8	0.0124	2.8	Lower
Chromium	2.5	142	133	193	2.6	222	0.12	222	Lower
Cobalt	NC	NC	NC	NC	NC	NC	NC	NC	NC
Copper	2.3	7.1	171	9.7	2.45	11.3	0.634	11.3	Lower
Hexavalent Chromium	NC	NC	NC	NC	NC	NC	0.41	11	NC
Iron	340	1000	78084	1000	403	1000	670	1000	Higher
Lead	0.5	1.9	0.38	2.8	0.58	3.4	0.0089	3.4	Lower
Manganese	NC	NC	NC	NC	NC	NC	NC	NC	NC
Mercury	ND	0.77	ND	0.77	ND	0.77	ND	0.77	NC
Nickel	4.6	41	1921	56	4.64	65	5.69	65	Higher
Selenium	1	5	1.93	5	0.99	5	0.887	5	Lower
Silver	NC	NC	NC	NC	NC	NC	0.011	5.5	NC
Thallium	NC	NC	NC	NC	NC	NC	NC	NC	NC
Vanadium	NC	NC	NC	NC	NC	NC	NC	NC	NC
Zinc	10	94	116	128	12	149	2.05	149	Lower

Table Notes: Concentrations of dissolved metals, except for aluminum, iron, and selenium which are total concentrations; * data from Table L-2 of Appendix L of the FFS Report; ** data compiled by OEHHA from the Site Characterization Report (see text); “ND” indicates not detected; “NC” indicates no applicable aquatic life criteria, or not calculated.

Table 4. Ecological Hazard Estimates for Remedial Alternatives

Chemical	Background	No Action	Recommended	Current
Aluminum	0.14	356	0.26	0.23
Antimony	NC	NC	NC	NC
Arsenic	0.0049	6.4	0.0053	0.016
Barium	NC	NC	NC	NC
Beryllium	NC	NC	NC	NC
Cadmium	0.12	0.63	0.11	0.0044
Chromium	0.02	0.69	0.012	0.0005
Cobalt	NC	NC	NC	NC
Copper	0.32	17	0.22	0.056
Hexavalent Chromium	NC	NC	NC	0.037
Iron	0.34	78	0.40	0.67
Lead	0.26	0.14	0.17	0.0026
Manganese	NC	NC	NC	NC
Mercury	NC	NC	NC	NC
Nickel	0.11	34	0.071	0.088
Selenium	0.20	0.39	0.20	0.18
Silver	NC	NC	NC	0.0020
Thallium	NC	NC	NC	NC
Vanadium	NC	NC	NC	NC
Zinc	0.11	0.91	0.081	0.014
Hazard Index (Sum)	**1.6**	**496**	**1.5**	**1.3**

Table Notes: “NC” indicates no applicable aquatic life criteria, or not calculated.

Conclusions

Overall risk and hazard calculations were performed correctly, but there are several big picture issues that limit the usefulness of this risk assessment for risk management decision making.

- It is not clear what is being referred to as “background”. Background concentrations should be from water that is not impacted by site contaminants, such as surface water upstream of the mine.
- For human health, the resulting hazard index of 47 for the Recommended Alternative in the FFS Report is clearly over the generally acceptable threshold of 1. The cancer risk estimate was 4E-4, resulting from arsenic, only carcinogenic

contaminant at the site. This risk estimate is over the high end of the risk management range, indicating that the risk should be addressed unless it can be shown to be due to background levels of arsenic.

- The hazard index for ecological effects for the Recommended Alternative, in the FFS Report was 2.1, which is over the generally acceptable threshold of 1.
- The proposal in the FFS Report leaves a long stretch of Leviathan and Bryant creeks with elevated ecological and human health hazard. The FFS report only assesses the hazard at one location over 2 miles downstream from the point of discharge, and a little over 1 mile beyond the property boundary. To understand the impacts of proposed actions, the risk should be assessed for a location at the point of discharge and a couple of locations downstream. Risk at the point of discharge should be compared to the risk for upstream, un-impacted water of Upper Leviathan Creek (as background). These risk estimates should be included in the FFS report or the baseline ecological risk assessment, so that all stakeholders are clear on the risks at the site and off-site and the changes in risk resulting from potential remedial actions. The FFS Report mentions that institutional controls will be used to address the human health hazard. Institutional controls will not protect wildlife.
- It seems that conclusions were made about the need to address human health impacts and not ecological health impacts, and the rationale for dismissing the ecologic impacts is not apparent in the FFS Report.
- The FFS Report does not make clear the benefits of the proposal in reducing risk compared to the current state of the site. The FFS Report demonstrates significant risk reduction by the Recommended Alternative compared to the No Action Alternative. However, the no action alternative does not represent current conditions. In comparing the Recommended Alternative to current conditions (data compiled by OEHHA), the benefits of the Recommended Alternative are not obvious. There were some important caveats to this assessment:
    - The data used for “current conditions” was compiled by OEHHA using data from the Site Characterization Report, but there were some data limitations in representing average concentrations at SW-27, as noted earlier in this memorandum.
    - The metal concentrations predicted by Wood for the Recommended Alternative are based on several estimated parameters. There may be too much uncertainty in those values to make a reliable comparison to current conditions.

    - FFS Report explains that the Recommended Alternative has benefits other than risk reduction, such as reliability, and operational flexibility, that are not discussed in this memorandum.

- Treating all acid drainage year-round instead of only for 9 months (for some discharges) will reduce ecological and human health risks. The benefit of the risk reduction from year-round treatment should have been included in the risk assessment section of the FFS Report.
- The remedial action objectives describe exposures of concern. Some routes of exposure are omitted. The contaminants in the creek also indirectly affect terrestrial plants and animals, and there may be indirect human exposures. These exposure routes should be included in the baseline risk assessment.
- A statement on mercury analytical limits in the FFS Report is inaccurate. Current analytical methods for mercury in water can measure mercury at concentrations below 50 ng/L.
- Development of a work plan of the FFS Report for stakeholder review would have helped to vet the main aspects, such as the alternatives that were considered and the locations for which risks were calculated.

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ENCLOSURE 4

Lahontan Regional Water Quality Control Board

January 14, 2022

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Comments on Atlantic Richfield Company's Technical Impracticability Evaluation for the Early Final Remedial Action for Operable Unit 1, Leviathan Mine Site

Thank you for the opportunity to comment on Atlantic Richfield Company's (AR's) Technical Impracticability Evaluation (TIE) for the Early Final Remedial Action (EFRA) for Operable Unit (OU-1) for the Leviathan Mine Site in Alpine County, California dated September 30, 2021. For groundwater, AR seeks a technical impracticability (TI) waiver for all applicable and appropriate requirements (ARARs) identified in the OU-1 Focused Feasibility Study (FFS) for both the entire area of mine-influenced groundwater at or near the mine and the remainder of the Leviathan Creek watershed, both upgradient and downgradient of the mine-disturbed areas. AR also seeks numerous TI waivers for applicable surface water standards for the metals aluminum, arsenic, beryllium, manganese, mercury, and thallium, as well as to waive application of State Water Resources Control Board Resolution 92-49 (Res. 92-49), from the mine site to a location several miles away in the state of Nevada.

Regional Water Quality Control Board, Lahontan Region (Water Board) staff understand and agrees that a TI waiver may be appropriate for groundwater in certain limited geographic portions of the site and for certain metals in surface water; however, in the view of the Water Board staff, the analysis contained in AR's TIE report contains serious defects that must be addressed before the United States Environmental Protection Agency (USEPA) considers whether to issue a TI waiver for OU-1, and the proper scope of any such waiver. With respect to groundwater, the TIE does not adequately establish background conditions, nor does it contain sufficient information or analysis to define the appropriate geographic scope of such waiver. The conceptual site model underlying the analysis is not sufficiently robust to establish such scope. With respect to surface water, AR erroneously seeks a TI waiver of Resolution 92-49 with no valid justification, declines to follow the proper substantive sequencing approach for a TI waiver, and seeks to waive standards for many more metals than is warranted based on available data.

Despite these and other serious deficiencies in the TIE, Water Board staff believes there is a path forward for identifying appropriate cleanup standards for groundwater and surface water at the site, including what limited and discrete waivers may be necessary. Before any waiver is finalized, AR must observe the appropriate, phased approach, including conducting sufficient site characterization and trying additional source control measures such that the scope of any waiver granted may be appropriately limited. Given that AR seeks to implement the EFRA prior to completing the site-wide OU, which will consider source control measures, sediment and floodplain soils, among other things, USEPA could consider a discrete TI waiver for groundwater within the mine workings and within the main excavated area. The analysis for such a waiver must follow the substantive requirements of federal and state law, which will limit the extent of such a waiver. That approach could be paired with an appropriately tailored institutional control (IC) program. The geographic scope of the TI waiver and IC program could be finalized during remedial design, similar to the cases cited by AR in the TIE, such as the Elizabeth Mine and Ely Copper Mine.

As USEPA is aware from prior comments submitted by the Water Board, significant questions remain regarding AR's conceptual site model (CSM), which is a critical component for a TI waiver. One approach, which was also used at the Ely Copper Mine, would be to further evaluate the CSM as part of remedial design.

For surface water, the TIE should evaluate a contingent TI waiver that could be used following the operation of the treatment plant once additional information is available about the ability of the plant to meet certain standards under various conditions. For certain metals, such as thallium that is not treated by the high density sludge treatment process, alternative treatment methods such as reverse osmosis or ion exchange should be pilot tested to see if applicable standards can be achieved or if contaminant levels can be appreciably lowered. While AR presents a limited analysis of those technologies, that analysis is not adequate, as explained in the Water Board comments on the FFS. If well-supported, Water Board staff is open to supporting such a request, so long as it includes the following components:

- For groundwater
    - Proper delineation of site characteristics and presentation of a defensible CSM (or completion of additional work on the CSM during remedial design)
    - Proper determination of background concentrations pursuant to applicable state law
    - Correction of inconsistencies and unsupported assumptions in the current analysis
    - Adherence to the substantive requirements of Res. 92-49 for situations where background concentrations cannot be achieved, and if needed, to identify the containment zone

- For surface water

  - Proper application of Res. 92-49 to determine remedial goals and, if needed, to identify the containment zone
  - Application of state substantive requirements to determine appropriate effluent limits for water treatment (the approach approved by EPA in California's Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, State Implementation Policy (SIP).
  - Proper phasing to help identify any necessary waivers of limited scope for discrete metals and how they will be implemented at the site in a limited manner and revisited over time (a containment zone, contingent ARAR waiver, etc.)

- Overall
  - Demonstration that site characteristics are sufficiently well understood for waivers requested
  - Explanation of how additional source control efforts and/or active remedial technologies were conducted before seeking waiver as a last resort or contingent waivers based on the outcome of future source control efforts
  - Explanation of how the requested waiver is as limited as possible in all respects (geographic scope, temporal scope, application of next most stringent standard where possible, etc.)

Below, the Water Board provides background on the legal requirements, greater detail on the elements of the draft TIE that require revision, and the Water Board's thoughts on what an appropriate TIE could look like for the Site. The Water Board also includes more detailed technical comments, included as Attachment A to this letter, for review and analysis by USEPA.

Background

Section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires remedial actions at CERCLA sites to attain legally applicable and appropriate federal and state requirements, standards, criteria, and limitations—collectively referred to as "ARARs"—unless such ARARs are formally waived by EPA. 42 U.S.C. § 9621(d). Applicable requirements are cleanup standards, standards of control or other substantive requirements promulgated under federal or state law. Relevant and appropriate requirements are standards under federal or state laws that are not directly applicable but nevertheless address problems or situations sufficiently similar that their use is appropriate at the site. A TI waiver is appropriate when it is technically impracticable from an engineering perspective to achieve compliance with an ARAR within a reasonable timeframe. USEPA must consult with states throughout the process of identifying and applying ARARs, including when considering whether a TI waiver is appropriate for any state ARAR.[1]

[1] Close coordination between EPA and states should occur throughout the ARAR-setting process such that there is "an open dialogue between EPA and the state throughout both the RI/FS process and the selection of a preferred remedy alternative in a proposed plan. . ." EPA, OLEM Directive 9200.2-187, "Best Practices for Identifying and

To show a waiver is warranted, the remediating party's TIE should "include a demonstration that no other remedial technologies or strategies would be capable of achieving . . . restoration at the site." EPA, OSWER Directive 9234.2-25 (Sept. 1993) (herein after "1993 TI Guidance") at 18. And parties seeking waiver must establish "alternative, protective remedial strategies." 1993 TI Guidance at 1. The waiver must be targeted in geographic scope, for instance by establishment of a site-specific cleanup goal within a narrowly defined TI zone, while the area outside the TI zone must still meet ARARs. If the TI zone cleanup levels exceed acceptable risk levels for humans or the environment, additional measures, like institutional controls, may also be required. Further, the waiver must be targeted in terms of how much standards are relaxed within the TI zone; generally, the assumption is that if a waiver of an ARAR is granted, the next most stringent ARAR should apply 1993 TI Guidance at 20. Finally, the waiver should be targeted temporally, if possible, such that remediating parties continue to evaluate further risk reduction as appropriate. 1993 TI Guidance at 21. EPA directs that if there is uncertainty about the ability to meet cleanup levels, a final ARAR-compliant Record of Decision (ROD) is usually still required; however, it may be appropriate to include contingency language that addresses specific actions to be taken if the selected remedy is unable to achieve all ARARs. 1993 TI Guidance at 5. TI waivers should only be granted if the statutory criteria are met, when groundwater cleanup is truly impracticable, and if granted, a waiver decision "should be scientifically supported and clearly documented." EPA, Summary of Existing EPA CERCLA Policies for Groundwater Restoration, OSWER Directive 9283.1-33 (June 26, 2009) at 3. EPA also instructs that "the state or tribe with jurisdiction over the groundwater often can have an important role in framing EPA's approach to groundwater characterization and remediation under Superfund." OSWER Directive 9283.1-33 (June 26, 2009) at 3.

EPA cautions that ARARs are generally *not* appropriate prior to remedy implementation. Such "front-end TI waivers," like the one AR seeks here, are generally unwarranted and unwise because waivers really should be granted only "after interim or full-scale aquifer remediation systems are implemented because it is difficult to predict the effectiveness of remedies based on limited site characterization data alone." 1993 TI Guidance at 10. Where they are granted, waivers "must be supported adequately by detailed site characterization and data analysis" and they must "focus on data and analysis that define the most critical limitations to groundwater restoration." In general, front-end TI waivers are more suitable if the remediating party has followed an appropriately phased approach to remedy implementation, seeking a TI waiver only after other measures have failed. And ARAR waivers are much more appropriate for an interim remedy when

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Determining State Applicable or Relevant and Appropriate Requirements Status Pilot" (Oct. 20, 2017) at 5. Where a TI waiver is sought, EPA must provide notice of its intent to waive the ARAR in the Proposed Plan and respond to any state agency or public comments concerning the waiver. 1993 TI Guidance at 23. USEPA counsels that "[s]tate concurrence should be sought, but is not required, for all remedy decisions in which EPA invokes an ARAR waiver." 1993 TI Guidance at 24. "Where the ARAR to be waived is a state ARAR, EPA must notify the state and provide the state with an explanation of any waiver of a state standard" as required by CERCLA and the NCP. 1993 TI Guidance 24 (citing NCP § 300.5155(d)(3) and CERCLA § 121(f)(1)(G)). The "TI review team" that considers any TIE should include state representatives. *See* EPA, Consistent Implementation of FY1993 Guidance on Technical Impracticability of Ground-water Restoration at Superfund Sites (Jan. 19, 1995) (hereinafter "1995 TI Guidance") at 5.

a final remedy is expected later on that will not require any waiver of ARARs. 1993 TI Guidance at 5.

However, there are circumstances where a front-end TI waiver, if properly tailored, may be appropriate. In fact, AR cites two such scenarios: the Ely Copper Mine and the Elizabeth Mine. TIE at 9. Both serve as examples of how front-end TI waivers may be properly used at mine sites as measures of last result if they are narrow in scope. At the Ely Copper Mine, significant deposits of unmined ore remain in the ground along with naturally occurring minerals capable of leaching into the groundwater indefinitely. USEPA approved a front-end TI waiver for groundwater in the underground mine workings only. *See* EPA, OU2 and OU3 Record of Decision, Ely Copper Mine Superfund Site (July 2016) at 51. A key component of the waiver was a commitment to conduct a groundwater pre-design investigation (PDI) to determine the extent of the contamination and the necessary extent of the use restrictions. The TI waiver was limited in geographic extent to the mine workings and the use restrictions were limited to the mine workings plus the areas that would draw water from them. Long-term monitoring and site inspections were put in place. Ely Copper Mine ROD at 51. Recognizing that insufficient data existed to determine the appropriate scope of the waiver and the use restriction, the selected remedy includes the PDI to "further develop the [CSM] from Underground Workings and to delineate the extent of the groundwater use restriction area . . . The types of activities that may be performed include: additional bedrock outcrop evaluations; surface geophysical investigation; installation of additional bedrock monitoring wells; groundwater sampling; and 3-D Digital Model and Groundwater Modeling." Ely Copper Mine ROD at 51. Further, the selected remedy includes installation of a passive chemical treatment system to treat the discharge from the main adit and instituted ICs. Ely Copper Mine ROD at 51.

For the Elizabeth Mine, EPA completed both a time-critical removal action to stabilize the tailings and improve surface water drainage from the mine, and a second removal action to control the release of acid mine drainage. EPA, Record of Decision, Elizabeth Mine Superfund Site (Sept. 2006), at 6. EPA then incorporated a TI waiver for remediation of groundwater within the mine workings only as a component of the site-wide final ROD. Elizabeth Mine ROD at 6. EPA determined that it would be practicable to collect and treat discharge from the underground workings or to prevent the spread of contamination from the workings into the adjacent aquifer but determined that there were no practicable actions that could be undertaken to achieve groundwater standards within the underground workings for the inorganic constituents present in the naturally occurring material at the site (cadmium, copper, manganese, mercury, and nickel). Elizabeth Mine ROD at 6. A TI zone was implemented to encompass that heavily disturbed area of the site. Elizabeth Mine ROD at 6. Additional containment and surface water controls, as well as ICs, were also implemented. Elizabeth Mine ROD at 6.

AR apparently references Ely Copper Mine and Elizabeth Mine to make the point that hard rock mine sites with an abundance of sulfide minerals, water, and oxygen should qualify for TI waivers because they have continuing sources of contamination and extremely long remedial timeframes. TIE at 9. While the Water Board disputes that waivers should be applied broadly and without limitation at mine sites, those two

specific sites *are* prime examples of mine sites that can obtain TI waivers if proper source control, site delineation, and overall remedial sequencing are observed, and the waivers sought are properly limited. They are instructive models for the analysis here.

Groundwater

AR maintains a waiver is required for all ARARs identified in the OU-1 FFS for the entire area of mine-influenced groundwater at or near the mine and the remainder of the Leviathan Creek watershed because "there are not effective practicable remedial technologies other than [ICs] for groundwater to address mine-influenced groundwater at or near Leviathan Mine." TIE at 1. This extremely broad waiver request is not justified and AR's analysis is faulty in multiple respects. AR has not appropriately delineated the lateral and vertical extent of the plume, has not established whether that plume is stable, expanding or shrinking, nor has it designed an adequate CSM. AR erroneously concludes it cannot determine background concentrations. Its analysis contains obvious logical inconsistencies. AR must re-analyze groundwater for OU-1 to appropriately consider whether groundwater ARARs can be met, and if some cannot, what narrowly tailored, supportable standards can be instituted in their place and in what locations.

Insufficient site characterization

A CSM is a scientifically defensible foundation for decision-making that evolves as the site investigation and remediation progresses. It is necessarily iterative. California Department of Toxic Substances Control (DTSC) Guidelines for Planning and Implementing Groundwater Characterization of Contaminated Sites (June 2012) at 12; Res. 92-49II.A.1. It describes the site geology, hydrology, groundwater contamination sources, and identifies the transport and fate of contaminants at the site. It is one of six required elements for a TIE, and decisions on any waiver "must be based on a thorough characterization of the physical and chemical aspects of the site." *See* 1993 TI Guidance at 13. Only when site characterization is complete should remedy selection occur. DTSC Guidelines for Planning and Implementing Groundwater Characterization of Contaminated Sites (June 2012) at 12. A CSM "is based on and should be supported by, interpreted graphics, reduced and analyzed data, subsurface investigation logs, and other pertinent characterization information." *See* 1993 TI Guidance at 13. EPA cautions that because the CSM "serves as the foundation for evaluating the restoration potential of the site and, thereby, technical impracticability as well [. . .,] the clarity of the conceptual model (and supporting information) is critical to the decision-making process. *See* 1993 TI Guidance at 13. At base, "the level of investigation must be sufficient to determine the risks to human health and the environment and to evaluate potential remedies." DTSC Guidelines for Planning and Implementing Groundwater Characterization of Contaminated Sites (June 2012) at 2.

The Water Board questions the accuracy of AR's site characterization. First and most importantly, AR has not accurately delineated the extent of the groundwater plume, a foundational step on which all further groundwater efforts depend. AR has not installed sufficient groundwater monitoring wells to determine the edges and depth of the plume, or to identify its rate and direction of movement. A basic analysis of a groundwater

plume at a site (with dissolved contaminant in a nearly homogenous and isotropic aquifer with little variation in groundwater flow) would include the following monitoring wells, at minimum:

- Upgradient – to provide background water quality
- Within a plume – to identify the distribution of contaminant concentrations
- At either side of the plume – to define the lateral extent of contamination
- At the downgradient edge of the plume – to monitor its migration
- Clusters in a contaminated water-bearing zone – to identify the vertical extent of contamination
- In underlying water-bearing zones – to identify the presence or absence of contamination

DTSC Guidelines for Planning and Implementing Groundwater Characterization of Contaminated Sites (June 2012) at 42; *see* also Cal/EPA, Monitoring Well Design and Construction of Hydrogeologic Characterization (1995d). Here there has been insufficient sampling along the edges of the plume such that its extent is not yet known, such that even a preliminary site assessment has not yet been performed in a satisfactory manner. Res. 92-49II(A)(1)(a) & (b).

Further, given that this is a mine site with fractured volcanic and sedimentary bedrock, appropriate sampling via bedrock wells is necessary to understand if and/or how contaminated groundwater is moving through bedrock. Without installing sufficient bedrock wells, AR's consultant concluded that "there is no evidence of the migration of mine-influenced groundwater in the bedrock beyond the boundaries of the Site." Evaluation of Groundwater Conditions, Leviathan Mine, S. S. Papadopulos & Associates, Inc. (Jan. 11, 2021); *see also* TIE at 7 ("groundwater flow in bedrock is minor relative to the flow in the overlying unconsolidated materials."). Additional downgradient bedrock wells are necessary to create an understanding of how mine-influenced groundwater is moving in the bedrock. *See* Desert Research Institute, Recommendations on the Evaluation of Groundwater Conditions, Leviathan Mine, by S.S. Papadopulos & Associates, Inc. (May 12, 2021) Report [hereafter "DRI Report"] at 1. Another core problem with AR's analysis is that water sampling was conducted in a record wet year (2017), so water level contours created are not likely typical of normal or drought conditions, which are more prevalent than wet conditions. *See* DRI Report at 2. AR's analysis of the relevant aquifers is also suspect. A sufficient site characterization requires delineation of aquifers and aquitards beneath a site, as well as any geologic features that may affect groundwater movement, depths to water table, seasonal groundwater variations, and composition of properties of soil and rock in the overlying vadose zone. DTSC Guidelines for Planning and Implementing Groundwater Characterization of Contaminated Sites (June 2012) at 25. To conceptualize where and how contaminants move in groundwater at the site, AR must have an understanding of the regional, intermediate, and local aquifers and how they interact. AR refers to the bedrock aquifer as a "regional aquifer" when it should be considered a local aquifer in a recharge zone. The properties of all aquifers should be adequately described. *See* DRI Report at 6, 14-15. DRI anticipates that over ten additional bedrock wells are required to

understand the flow of contaminated groundwater through bedrock at the site. *See* DRI Report at 15.

Without an appropriate characterization of the site, selection of a remedy and request for waivers of applicable ARARs are premature. Site characterization basics require that AR collect more data to determine the extent of the plume before finalizing its remedial design for groundwater or clarifying if and where any TI waivers for groundwater may be required. EPA cautions that front-end TI waivers like the ones AR seeks "will require very thorough site characterization . . .." *See* 1995 TI Guidance. AR's TIE does not reflect a thorough site characterization sufficient to justify any TI waiver, much less a front-end waiver as broad in scope as what it seeks.

Unsupported assumptions

AR's TIE contains assumptions that are not adequately explained and may prove to be incorrect. For example, acid mine-influenced groundwater is designated as groundwater with sulfate levels > 200 mg/L and a pH $\leq$ 6.5, but the reasoning for setting this criteria is not explained, and the Water Board's consultant DRI maintains that sulfate concentrations greater than 200 mg/L is too high of a level for defining mine-influenced groundwater. TIE at 7; *see* DRI Report at 10. As further justification for the waivers it seeks, AR theorizes that calcite will neutralize acidic groundwater in certain areas of the site, but does not provide sufficient evidence for that theory. *See* DRI Report at 11-12. AR also states that groundwater at the site is accounted for and reports to the surface water that is being collected and treated, except for a small amount, and therefore will mostly be remediated via the treatment plant and does not require separate treatment as groundwater. However, without proper characterization of the groundwater plume, its movement, and overall site characteristics, there can be no way to know if this is in fact the case.

Defining background

Comparing contamination from the site to background concentrations is an effective way to manage and evaluate risk at a contaminated site. A disadvantage of not characterizing contamination to background concentration is that viable risk management options may be prematurely eliminated based solely on lack of data. DTSC Guidelines for Planning and Implementing Groundwater Characterization of Contaminated Sites (June 2012) at 28 See also 92-49 II.A.1.a through e (preliminary site assessment, soil and water investigation to determine the source nature and extent of the discharge with sufficient detail to provide the basis for decisions regarding subsequent cleanup and abatement actions, proposal and selection of cleanup and abatement action, and monitoring to confirm short- and long-term effectiveness). AR erroneously contends that a waiver is required because background cannot be determined sufficiently to implement a cleanup. But AR ignores that it must defer to a State's criteria and methodology with respect to groundwater where such state standards are sufficiently protective, as California's are. *See generally,* OSWER Directive 9283.1-33 at 7. Generally, California law requires characterization of background by measuring a sufficient number of background monitoring points installed

at appropriate locations and depths to yield groundwater samples from the aquifer that representing the quality of groundwater not affected by the release(s) in question. *See generally* Res. 92-49 II.A.1 There is no reason that substantive approach should be different here or should not be followed here.

Determination that ICs are the only option

Per EPA Guidance, "an IC by itself generally should not substitute for active remediation of groundwater." OSWER Directive 9283.1-33 at 5 (citing 40 C.F.R. 300.430(a)(iii)(D)). ICs are to be used as "supplementary protective measures during implementation of ground-water remedies." National Contingency Plan ("NCP") Preamble, 55 Fed. Reg. 8732 (Mar. 8, 1990). In the limited circumstances where an IC-only final remedy truly is appropriate, it would follow selection of other remedial action elements in previous decision documents, and any such determination should trigger consultation between USEPA regional staff and the appropriate Regional Coordination from the Office of Superfund Remediation and Technology Innovation to ensure the decision making process appropriately evaluates and properly documents key aspects of the decision-making process leading up to the decision. OSWER Directive 9283.1-33 at 6.

AR determines that there are no effective practical remedial technologies for mine-influenced groundwater at the Site. TIE at ES-2. As shown above, AR does not have sufficient data and site understanding to reach that conclusion. Additionally, AR has not explored some source control options, like revegetation, capping, or cutoff walls, that it could and should explore. USEPA expects that at sites with a continuing source area that renders plume restoration difficult, remediating parties will explore hydraulic containment at the leading edge of the aqueous plume, and, if necessary, establishment of less-stringent cleanup levels throughout the plume as well as natural attenuation or natural gradient flushing. There is no precedent for a determination that ICs are the only option without a proper analysis of other such approaches. Evaluating all options is also a requirement of state law. Res. 92-49 requires dischargers to actually consider a list of cleanup and abatement methods or combinations thereof. *See* Res. 92-49 III.E (listing a variety of techniques for source removal, in-place treatment, excavation or extraction for treatment, and excavation for recycling, re-use, or disposal). Res 92-49 requires a phased approach to investigate, cleanup, and abate impacts in a progressive manner, with different impacts remediated concurrently or sequentially. Res. 92-49.III.A.I, A.2. The investigation must include investigation, cleanup, and abatement to any location affected by the discharge or threatened by the discharge. Res. 92-49.III.A.3. It is *not* sufficient to simply determine there are not practical remedial technologies without completing a sufficient site investigation or considering all available remedial options.

Continued evaluation of risk and tightening of standards

Rather than approving a front-end TI waiver for groundwater, USEPA guidance provides for a phased and targeted approach, where data is collected, the remedy is further defined, and standards are tightened *before* any waiver absolutely required is approved. This approach can help "determine the restoration potential of a site." 1993 Guidance at 2-3. And EPA expects that future migration of the contaminated groundwater will be prevented, exposure to contaminated groundwater will be prevented, and there will be evaluation of further risk reduction as appropriate. 1993 Guidance at 21.

One approach could be to evaluate in the TIE a waiver limited to the mine workings and within mine waste, and to defer a determination of the exact geographic extent of that waiver until the remedial design. This is the approached used at the Ely Copper Mine. At that site, EPA issues a TI waiver for groundwater within the mine workings and left the scope of the waiver and IC program to the remedial design phase.

Surface Water

SWRCB Resolution 92-49

AR seeks a waiver "to the extent required for Surface Water Quality Control Board Resolution 92-49 Section III.G because of the inherent difficulty in defining background concentrations at historic mine sites." TIE at 23. AR states that because mining predates reliable sampling, there are no ascertainable pre-mining baselines to analyze, and because the geochemical composition of the geologic material is variable, analysis is complex. TIE at 23. AR seeks to identify a zone of surface water within Leviathan Creek and Bryant Creek downstream of the mine to the East Fork of the Carson River that is exempt from Res. 92-49. TIE at 24.

Res. 92-49 requires dischargers to cleanup and abate the effects of discharges in a manner that promotes attainment of either background water quality or the best water quality which is reasonable if background levels cannot be restored. Res. 92-49 at III.G.[2] If background levels cannot be restored, cleanup levels less stringent than background must (1) be consistent with maximum benefit to the people of the state; (2) not unreasonably affect present and anticipated beneficial use of such water; and (3) not result in water quality less than that prescribed in the Water Quality Control Plans and Policies adopted by the State and Regional Water Boards. Res. No. 92-49 at IIIG.

Neither "difficulty" nor "status as a historic mine site" are an acceptable basis for a TI waiver. AR misleadingly asserts that EPA routinely reaches the conclusion that Res. 92-49 should not be applied as an ARAR to mine sites, but none of the examples AR uses actually support that conclusion.

[2] AR identifies Res. 92-49 as a potential ARAR and seeks a waiver "to the extent required," indicating it has not fully conceded that Res. 92-49 is an ARAR for the site. TIE at ES-3, 23, Table 5-1 Res. 92-49 outlines the policies and procedures that the Regional Water Boards are required to apply for the investigation and cleanup and abatement of discharges subject to section 13304 of the California Water Code. Res. 92-49 meets the requirements for "applicable" or "relevant and appropriate" standard for groundwater remedies because: (1) it is substantive in that it sets a level or standard of control, albeit a narrative one, *see* III.G; (2) it is a promulgated standard, being a state standard of general applicability that is legally enforceable; and (3) it provides a requirement more stringent than federal requirements. 40 C.F.R. § 300.5.

First, AR states that EPA "has repeatedly waived or declined to designate Resolution 92-49 as an ARAR in setting water quality performance standards for remedial actions at CERCLA mine sites in California," citing to the decisional documents for three California mine sites: the Lava Cap 2004 ROD, the Iron Mountain Mine 1992-1994 I-RODs, and the Walker Mine 1994 ROD/2001 AROD. TIE at 23. The analyses conducted in these documents does not include any detailed discussion of Res. 92-49, and certainly none contain any statement that would support AR's conclusion that EPA does not apply Res. 92-49 to mine sites. Indeed, these three sites illustrate the Water Board's position that any waiver should be limited in nature and implemented via an interim ROD, not in an EFRA.

- The Lava Cap ROD contained no discussion of Res. 92-49, but it also did not request or receive any ARAR waivers. The 2004 ROD indicates some portion of the acid-generating waste rock was capped with wells installed to help detect future releases, and discharges of treated water were required to comply with the NPDES program. Groundwater for that site was handled by a separate OU. In short, this ROD adequately considered additional routes for source removal *and* no waivers were granted. *See* EPA, Lava Cap Mine Superfund Site Mine Area OU1 Record of Decision (2004) at section 13.

- Iron Mountain Mine had an interim ROD, with a commitment to continuing to study data and address whether applicable ARARs could be met site-wide. Further, the continuing discharges of AMD were addressed in a different action. The limited nature of the waiver requested, for a finite period of time in an interim ROD, is much more discrete than what AR requests here. EPA, Iron Mountain Mine Superfund Site Old and No. 8 Mines Record of Decision (1993) at VIII.2 and VIII.,X.2.2; EPA Iron Mountain Mine Boulder Creek OU2 Record of Decision (1992) at section VIII.2 and VIII.8.

- Walker Mine ROD applied only to the tailings site, not the actual mine site, and specific receiving water limitations were set for metals as ARARs. *See* EPA, Record of Decision for Remediation of the Walker Mine Tailings (1994) at section VI.

Second, AR points to a long list of mine sites in other states, asserting that USEPA declined to use background concentrations as a benchmark for water quality performance standards at those sites. *See* TIE at 23, N5. AR does not identify whether any of those states have state law requirements to remediate to background. Nonetheless, the majority of these non-California mine sites actually support the Water Board's position because the waivers of applicable standards at those sites were discrete and/or limited in nature or no waivers were granted at all.

- At Silver Bow Creek, a waiver of instream surface water performance standards for copper and zinc was granted only during wet weather events, and due to uncertainty as to whether some additional metals standards could be met after remediation, USEPA put in place a contingent waiver for surface ARARs for many

metals. EPA, Record of Decision for the Butte Priority Soils Operable Unit and the Silver Bow Creek/Butte Area Site (2020), at 33-34.

- For the Anaconda Smelter, certain Montana numeric water quality standards were waived, but the next most stringent (federal) standards were applied in their place. EPA, Record of Decision Amendment for the Anaconda Regional Water, Waste & Soils Operable Unit (June 2020) at 2-5.

- For the Eagle Mine, a waiver was granted for arsenic only in certain discrete surface water segments due to upstream load from non-site related sources. EPA, Final Record of Decision Amendment for the Eagle Mine Superfund Site Operable Unit 1 (Sept. 2017) at 12.

- The California Gulch waiver was limited to only two metals and for a very small geographic area and only to a depth of fifty feet. EPA, Record of Decision for Operable Unit 12, California Gulch Superfund Site (Sept. 2009) at DS-89 to 50.

- For the Gilt Edge Mine, selenium and TDS water quality standards were waived in the interim ROD but only for a short period of time. In the face of uncertainty as to whether the standards could practicably be met, USEPA waived the standards in the short term but anticipated that elements of source removal/source control like waste containment and capping would reduce contaminant levels such that the standards could be achieved in future. USEPA, Interim Record of Decision, Operable Unit 2, Gilt Edge Mine NPL Site (Nov. 2021) at 2-21.

- At the Bullion Mine, the waiver was limited in time as an interim ROD. The final remedial action required meeting all ARARs. EPA, Interim Record of Decision, Bullion Mine Operable Unit 06 (April 2015) at 10-4.

These examples show that waivers can be considered at mine sites, but not due to concern over establishing background; rather, the sites show that TI waivers should be narrow, limited and applied after source control efforts are considered and/or deployed. Here, once up and running, the treatment plant will achieve certain effluent limits (see next section), constrained by High Density Sludge (HDS) technology, potentially augmented by other treatment steps for some or all of the discharge. After the treatment plant is operational, it should be possible to determine whether a TI waiver is needed here, and if so, under what circumstances. To the extent a waiver is needed, AR should follow the substantive requirements delineated in Res. 92-49IIIH and establish a containment zone (if the requirements can be met), including but not limited to limiting the area of the containment zone and where appropriate action is taken to limit contaminant spread. That analysis could also consider the role of infiltrating groundwater on in-stream water quality. Additional data could be collected during remedial design to define the extent of the area where the TI waiver is required.

Application of SIP to set effluent limits

AR has made numerous assumptions in its analysis of surface water concentrations of metals at the site and prematurely jumped to the conclusion that no remedial technologies could attain ARARs for discharges of treated effluent to surface water within OU-1. TIE at sections 4.3 and 5.2. The Water Board anticipates that ARARs can be achieved for most metals under most conditions, and that if HDS is the only treatment approach, that not all metals will meet all ARARs under all conditions; however, the TIE must follow proper procedure to ascertain the appropriate effluent limits. And in particular, the TIE must utilize the procedures set forth in the SIP to establish effluent limits for the HDS treatment plant. The SIP establishes a standardized approach for permitting discharges of toxic pollutants to non-ocean surface waters in a manner that promotes statewide consistency. This standard approach requires evaluation of the impacts resulting from discharges to surface waters. The SIP has been approved by EPA and follows EPA guidelines for discharges to surface water. AR's analysis, by contrast, contains a surface water evaluation that is substantially incomplete with respect to determining potential impacts to surface water, calculating effluent limits, providing mixing zone calculations, determining assimilative capacity, as well as evaluating anti-degradation and selecting background concentrations. The analysis also does not account for the effect of floodplain soils or sediments, which will be addressed as part of the site-wide remedy. Any TI waiver for surface water must be narrowly prescribed to, among other things, avoid impairing potential sediment or other response actions as part of the site-wide remedy.

Consideration of which metals need waivers

The Water Board recognizes that discrete, limited waivers will probably be required for some metals, such as thallium (e.g. the high density sludge treatment method will not remove thallium) (but see comments re other treatment technologies). For other metals, the need for a waiver is not yet established, and AR must follow the appropriate procedure set forth in Res. No. 92-49 to set background levels and determine which waivers will be required. As an example, the Water Board anticipates that aluminum levels will be within background concentrations, given information about aluminum in the upstream receiving waters. However, for each metal, AR must conduct the appropriate analysis and arrive at separate conclusions that are supported by the site data. Performance standards may be able to be developed based on data in the 2020 HDS pilot study report but which has not yet been provided to Water Board staff. Once the plant is operational, performance standards, effluent limits and other water quality standards established, any conditional waiver could be evaluated consistent with state and federal requirements.

Overall Recommendations

AR seems to believe that because this is a complex site with a continuing source area and a long-time horizon for remediation, a TI waiver is a foregone conclusion. Not so. The presence of known constraints, like the inability to control the source area or a long-time horizon or other factors like costs, are not sufficient to justify a TI determination on

their own. *See* 1993 Guidance at 10-11. The AR must still prepare a proper TI analysis. The process of doing so will help delineate what narrowly tailored waivers are truly necessary and will contribute to the overall understanding of the site and the proper remedial plan.

Water Board staff look forward to continued collaboration with AR and USEPA on the Leviathan Mine site and would be happy to arrange a meeting to discuss the issues raised in this letter.

Sincerely,

MICHAEL R. PLAZIAK, PG
Executive Officer
California Regional Water Quality Control Board – Lahontan Region

Attachments:

Attachment A: Water Board comments

Attachment B: DRI comments on the TIE

Attachment C: DRI comments on TIE Appendix A

cc: Elizabeth Adams/United States Environmental Protection Agency, Region IX
Joshua Wirtschafter/United States Environmental Protection Agency, Region IX
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Steve Hampton/California Department of Fish and Wildlife
David Friedman/Nevada Division of Environmental Protection
David Risely/United States Forest Service/Humboldt-Toiyabe National Forest
David Coupe/State Water Resources Control Board, Office of Chief Counsel
Thomas Bloomfield/Kaplan Kirsch & Rockwell, LLP

Attachment A

Water Board Staff Detailed Comments on Atlantic Richfield's (AR) Technical Impracticability Evaluation (TIE) for the Early Final Remedial Action for Operable Unit 1, Leviathan Mine Site, Alpine County, California

1. Page ES-2 first bullet – It is well known that there is a substantial amount of mine waste and overburden saturated with groundwater; however, the amount of saturated in-situ ore body with acid generating potential is unknown. An estimation of these materials is included as Appendix A to the TIE report and the Water Board's consultant, Desert Research Institute (DRI), has provided review comments on this estimation (see Attachment C to this letter). In addition, no evaluation has been received estimating the cost to remove the acid-generating material and or evaluations of other technologies for source treatment or reduction. This information is required for the compliance with State Water Board Resolution 92-49.

2. Page ES-2 third bullet – Sufficient information has not been submitted to screen out collection trenches for improving groundwater collection at the mine. Collection trenches are currently in use at the site and could be improved. See S.S. Papadopulos and Associates' (SSPA) January 11, 2021 *Evaluation of Groundwater Conditions, Leviathan Mine, Alpine County, CA.* DRI has made a similar comment (see Attachment B to this letter). Water Board staff have received virtually no evaluation of attenuation, in-situ groundwater treatment, extraction wells or groundwater containment referenced in this bullet.

3. Page ES-2 second paragraph, first bullet – Impacts to surface water from treated effluent cannot be adequately evaluated without the submittal of the final results for AR's 2020 HDS pilot study.

4. Page ES-2 second paragraph, second bullet – The conclusion that tributaries to Leviathan and Bryant creeks will affect aquatic life regardless of acid mine drainage (AMD) treatment needs to be supported by data including which metals are being discussed, and a graphical and statistical analysis supported by isopleths overlain on site maps.

5. Page ES-2 second paragraph, third bullet – Although AR's 2020 HDS pilot study tested one multi-media filter as a polishing step, Reverse Osmosis and Ion Exchange technologies have not been tested and should not be screened out or used as justification for a waiver of water quality objectives. Pilot testing is recommended before these technologies are ruled out. Additionally, the results of the AR's 2020 HDS pilot study have not been submitted, so it is not possible to evaluate AR's calculations of effluent quality for the proposed HDS treatment plant. This severely impairs the ability to justify any waivers of water quality objectives or set other discharge standards.

6. Page ES-2 Groundwater TI Waivers Sought, second to last paragraph - Information required for a TI waiver is incomplete or technically deficient. The Water Board has identified State Water Board Resolution No. 92-49, as amended, as an Applicable or Relevant and Appropriate Requirement (ARAR) that contains the information and substantive requirements for designating a containment zone for groundwater. These State substantive requirements are similar to a TI waiver and allow for the setting of alternative clean up goals. The TIE does not include sufficient information to evaluate a containment zone nor is the proposal to identify the extent of the TI waiver as OU-1 for groundwater consistent with the State's Containment Zone Policy established by State Water Board Resolution No. 92-49 for the reasons outlined, below.

   a. The State's Containment Zone Policy, in part, requires containment zones to be "limited in horizontal and vertical extent; as protective as reasonably possible of human health and safety and the environment; and should not result in violation of water quality objectives outside the containment zone." TIE Section 3.2, second bullet states that mine-influenced groundwater in the unconsolidated zone is horizontally bound between Leviathan Creek and Aspen Creek. It appears that this provides a basis, if AR's groundwater conceptual model (as presented in SSPA's January 11, 2021 groundwater report) is accurate, to limit the horizontal extent of a containment zone and a TI waiver area for groundwater in at least the unconsolidated groundwater zone.

   b. Additionally, the conclusions set forth in SSPA's January 11, 2021 groundwater report regarding the location where mine-impacted groundwater fully surfaces (i.e., pinches out) into Leviathan Creek (500 feet past MW-51) and the proposal to include groundwater below this point in the TI waiver are inconsistent with the State's Containment Zone Policy, as the proposed containment zone would theoretically extend beyond the horizontal limits of mine-influenced groundwater below MW-51. And while the Water Board continues to question several elements of AR's conceptual groundwater model (as presented in SSPA's January 11, 2021 groundwater report), the Water Board believes outstanding issues such as the ones identified here will need to be resolved in developing defensible support for designating a containment zone and TI waiver.

   c. Providing a technically defensible approach to delineating the extent of mine-influence groundwater is critical to establishing a containment zone and TI waiver area that is limited in areal extent, rather than unnecessarily restricting the use of groundwater resources in areas that have not been affected by mining activities. The Water Board has identified a number of issues and provided comments regarding the approach used in the TIE and the Focused Feasibility Study (FFS) for OU-1 for delineating the extent of mine-influenced groundwater that still need to be addressed and resolved in order to provide a

technically defensible basis for designating a containment zone and identifying the extent of a TI waiver.

7. Page ES-2 Surface Water TI Waivers Sought, last paragraph – The fundamental technical documentation to support a waiver from discharge criteria is a demonstration of effluent quality achievable by the proposed treatment plant and a reasonable potential analysis to determine if the effluent may impact aquatic life or beneficial uses as defined in the Water Quality Control Plan for the Lahontan Region (Basin Plan). Water Board staff need the final results from the AR's 2020 HDS pilot study to facilitate review of this request. In addition, if the HDS treatment plant cannot meet one or more water quality objectives, an evaluation of discharge options found in the State's Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, State Implementation Policy (SIP) must be submitted to determine if there is assimilative capacity in Leviathan Creek and if the discharge meets the anti-degradation requirements or if a mixing zone is possible. This evaluation is needed to support whether a TI waiver may be appropriate for surface water. Finally, certain treatment techniques, such as Reverse Osmosis and Ion Exchange, have not been fully evaluated and should not be screened out before evaluations including pilot tests are completed to determine if water quality objectives can be met using these technologies.

8. Page 1, Section 1, Next to the last paragraph – Water Board staff and their consultant DRI have provided comments regarding the development and use of 200 mg/l sulfate as a background water quality concentration, which may not reflect background conditions at the site (see Attachment B to the FFS comment letter and Attachment B to this letter). Water Board staff believe that the basis for this number is questionable as outlined in earlier Water Board comments on the matter. Moreover, the Water Board does not understand how this sulfate concentration could presumably act as a surrogate for all metals being addressed by the Early Final Remedial Action (EFRA) for OU-1.

9. Page 4, Section 1.3.1 – SSPA's January 11, 2021 groundwater evaluation uses sulfate as an indicator for defining areas of mine-influenced groundwater. As stated, above, Water Board staff does not understand the basis for believing that sulfate is considered a good indicator for contaminant metals transport. Little, if any, information has been provided to support this claim. Moreover, the nature and extent of contamination has not been defined at this time. Isopleths are needed for each COC to delineate the nature and extents of the plume (see DRI comments in Attachment B to this letter).

10. Page 4, Section 1.3.2.a. – A demonstration that contamination sources have been identified and have been, or will be, removed and contained to the extent practicable. No cost estimate or evaluation has been provided regarding removal or containment of waste rock placed in Leviathan and Aspen Creeks during

mining which continues to be a source of contaminated Acid Mine Drainage (AMD).

11. Page 5, Section 1.3.3 – Cost estimates are to include the costs of operation and maintenance, but that information is not presented in the draft. This information is particularly important when evaluating the cost of operating and maintaining a landfill vs. offsite disposal. Costs for construction of a landfill should include at a minimum, double liners with leachate collection and treatment, the closure cap, and cost of maintaining and monitoring a landfill in perpetuity.

12. Page 7, Section 2.3, last paragraph – The TIE delineates the extent of mine-influenced groundwater (plume) using a sulfate concentration of 200 mg/L, see comment 9 for additional comments. At this time, the Water Board believes that isopleths are needed for all COC's to delineate the extent of the plume. Areas where the mapped extent do not appear to be supported by the use of 200 mg/L sulfate to define the extent of the plume include areas around MW-53 with sulfate at 817-1,170 mg/L and MW-52 sulfate at 500-1,240 mg/L and As is 30.8 ug/L (MCL As 10 ug/L). DRI has provided detailed comments about many of the conclusions in SSPA's January 11, 2021 groundwater report, including well installations needed to complete the groundwater characterization (see Attachment B to the Water Board FFS comment letter and Attachment B to this letter).

13. Page 8, Section 2.4, first paragraph – Conclusions about the amount of groundwater that escapes collection in the current site collection system have been raised by DRI (see DRI comments in Attachment B to this letter). Considering the entire Aspen Creek side of the site discharges groundwater, uncollected and untreated, to Leviathan Creek, the Water Board questions this conclusion as well. Questions regarding the water budget which defines the percentage of groundwater discharging without treatment have also been raised by Water Board staff and DRI. The Water Board believes that screening out collection trenches as a means to contain groundwater at the site is not appropriate and has also been questioned by DRI (see DRI comments in Attachment B to this letter).

14. Page 8, Section 2.4, second paragraph – Statements regarding the assimilative capacity of Leviathan Creek and tributaries need to be evaluated using the SIP. The statements that the tributary flows dilute Leviathan discharges is only true when there is flow in those tributaries. In this case, the 1Q10 and 7Q10 flows are zero or nearly zero, indicating that Leviathan Creek is without flow and would be effluent-dominated during these times and with extremely little if any assimilative capacity. The SIP defines the substantive requirements for evaluating the impacts of discharges in times of low flows when the Leviathan Creek system would be effluent-dominated and no dilution occurs. In this situation, in the absence of any assimilative capacity and a corresponding mixing zone, the SIP requires that effluent limits be met at the end of pipe. In addition, State Board Resolution No. 92-49 specifies that discharges do not have to be lower than background. As an example, the discharge would not be required to have an

effluent limit lower than the aluminum in the receiving water (Upper Leviathan Creek).

15. Page 10, Section 3, second bullet – “Demonstration that source materials affecting groundwater have been identified and have been or will be contained or removed to the extent practicable”. Water Board staff continue to have questions regarding the source of contamination that remains and evaluations about source removal have not been submitted.

16. Page 10, Section 3, fourth bullet – Demonstration that no treatment technology can meet the ARARs. The final results for AR’s 2020 HDS pilot study have not been received which could inform whether effluent limits calculated per the SIP can or cannot be met. No demonstration has been provided to date that supports the conclusion that no treatment technology can meet ARARs.

17. Page 11, Section 3.1, second paragraph – Reference is made to the modeled extent of the ore body. Has this model been submitted? What is the estimated volume of ore body left in place? Is there a figure where the remnant ore body is shown both vertically and horizontally? Also see DRI comments provided as Attachment C to this letter.

18. Page 12, Section 3.2 – Water Board staff question the water balance and conclusions regarding the amount of groundwater escaping collection. DRI has questioned the conclusions that there is no mine-influenced groundwater in the bedrock or below the last monitoring well pair as well as other areas where the extent of contamination is not defined.

19. Page 12, Section 3.4, third paragraph – The text indicates that collection trenches are not implementable at this site when in fact collection trenches have been implemented at the site and SSPA’s January 11, 2021 groundwater report suggested additional collection trenches could be installed to improve collection. As a result, consistent with Comment 13 above, Water Board staff does not believe that collection trenches should be screened out at this time.

20. Page 14, Section 4.1 – Data analysis on effluent and surface water concentrations needs to be done following the SIP and use the data from the 2020 HDS pilot study for effluent concentrations to determine if effluent limits or background water quality from upper Leviathan Creek (ULC) can be met. See detailed comments in the Water Board FFS comment letter. Flow regimes to be used for this evaluation are defined in the SIP as the 1Q10 and the 7Q10. Downstream estimates of water quality are not conservative as stated because existing data show that downstream concentrations are higher than the estimates. The SIP needs to be used in establishing effluent limits.

21. Page 14 Section 4.1 – Data Analysis all bullets-Compliance with chemical specific ARAR’s in Leviathan Creek and all other surface water locations needs to be done on existing data, not estimates of concentration that have been calculated. Water Board staff have detailed comments on the estimate calculations in the Water Board FFS comment letter.

22. Page 15, Section 4.2.1, second bullet – Water Board staff is currently working with AR and SSPA to resolve issues with the water balance presented in SSPA's January 11, 2021 groundwater report. These issues are related to the manner in which SSPA estimated on-site accumulated precipitation in their groundwater report. Adjustments to these calculations may result in the need for revisions to the water balance presented in SSPA's groundwater report.

23. Page 15, Section 4.2.2, first paragraph – State Board Resolution 92-49 does not require cleanup to levels lower than background. As a result, Water Board staff does not understand why AR is asking for a waiver to State Board Resolution 92-49. State Board Resolution 92-49 requires cleanup in a manner that promotes attainment of either background water quality, or the best water quality which is reasonable if background levels cannot be restored.

24. Page 15, Section 4.2.2, second paragraph – Where existing data exists for surface water, this data should be used for this analysis and estimates of surface water quality used where no data is available.

25. Page 16, Section 4.3 – Water Board staff have detailed comments on the FFS screening of alternatives which should be taken into consideration before treatment technologies to supplement HDS (specifically Reverse Osmosis and Ion Exchange) are screened out. It is unclear what effluent data has been used to state that chemical specific ARAR's cannot be met for aluminum, arsenic, magnesium and thallium. As discussed in the comments on the FFS, it is premature to eliminate Reverse Osmosis and Ion Exchange as treatment technologies.

26. Page 23, Section 5.3, Waiving 92-49 – AR is seeking a TI waiver of the requirements in State Board Resolution 92-49 III.G, which require, among other things, "Hydrologic and hydrogeologic information, such as differences in upgradient and downgradient water quality." in site characterizations to facilitate cleanup actions. The failure the of the FFS to provide background concentrations or plume delineation such as isopleths for contaminants of concern (COCs) leaves Water Board staff without the necessary information to evaluate the TIE. Requesting a waiver from State Board Resolution 92-49.III.G is counterproductive since III.G allows site cleanup to the best water quality achievable if background levels cannot be restored. This is an essential tool in considering alternative clean up levels less stringent than background.

27. Page 24, Section 6.1 – Water Board staff does not understand why the SSPA's January 11, 2021 groundwater report indicates that the unconsolidated groundwater pinches out near MW-50 a short distance downstream of the mine and yet the TI Zone waiver is requested for groundwater downstream of that area. No explanation has been provided to support the proposed delineation for OU-1. There is no groundwater data below MW-50 to support this request.

28. Page 24, Section 6.2 – Similar to groundwater, there is very little to no technical information to support the extent of the requested TI Zone waiver for surface

water. The process used in the FFS to calculate surface water concentrations using data from upstream and flows from downstream while ignoring actual data does not follow the SIP for evaluation of surface water discharges and impacts to receiving waters as required. Additionally, the request for a TI waiver from meeting water quality objectives in the entire OU-1 for surface water has not been justified as necessary by evaluations of water quality throughout the reach and evaluation of impacts from sediment and potential treatment technologies in stream reaches in OU-1. Since sediment is not included in this action, how will impacts from sediment and mine waste downstream of the mine be investigated and evaluated for treatment technologies. Additionally, draft results for the 2020 HDS pilot study (Phase 4), show that manganese could be removed to below effluent limits calculated by Water Board staff and may not need a TI waiver.

29. Page 25, Section 7 – Water Board staff have detailed many technical issues with the conclusions in this TI waiver and cannot support the request until such time as there is a satisfactory resolution to these issues including all of the Water Board comments on the FFS, DRI comments, and comments provided by the Office of Environmental Health Hazard Assessment (OEHHA).

30. Table 4.1 – This table presents estimates of surface water concentrations at various flows using a “mixing zone like” methodology, but the approach does not follow the SIP as required. Certain flaws in this analysis include: (1) not using the correct flow rates to calculate concentrations in the downstream location of the mixing zone (1Q10, 7Q10), the Leviathan Creek1Q10 is zero or nearly zero, therefore the mixing zone is not allowed, and the compliance point moves to end of pipe for the discharge; (2) the analysis uses flow for one location (SW-15) and concentrations for another location (SW-1), thereby underestimating the concentrations downstream of the proposed discharge; (3) No evaluation was provided for anti-degradation for Leviathan Creek as required. Evaluating the appropriateness of a mixing zone involves consideration of the current water quality (using data downstream of the proposed discharge and determining if there is assimilative capacity left in the stream or if the discharge needs to meet water quality objectives at the end of pipe; and (4) At a minimum the TIE needs to include the effluent concentration the proposed HDS treatment plant is expected to produce to facilitate review of the TIE requests to waive water quality objectives. The effluent quality information should be provided with the final results for the 2020 HDS pilot study report which to date have not been submitted.

31. Figure 2.5 Extent of Mine Influenced Groundwater in Unconsolidated System – The Water Board does not understand how a TI Waiver is supportable given that the entire mine-influenced groundwater flow from the Aspen Creek side of the site is left to discharge contaminated groundwater with no containment or attempt at collection for treatment. In addition, pursuant to State Board Resolution 92-49, II.A, following requirements apply to investigations to determine the nature and horizontal and vertical extent of a discharge and appropriate cleanup and abatement measures in a progressive sequence ordinarily consisting of the following phases, provided that the sequence shall be adjusted to accommodate

site-specific circumstances, if necessary. These sequential steps include (1) preliminary site assessment (to confirm the discharge and the identity of the dischargers; to identify affected or threatened waters of the state and their beneficial uses; and to develop preliminary information on the nature, and vertical and horizontal extent of the discharge; (2) soil and water investigation; (3) proposal and selection of cleanup and abatement action (to evaluate feasible and effective cleanup and abatement actions, and to develop preferred cleanup and abatement alternatives); (4) implementation of cleanup and abatement action (to implement the selected alternative, and to monitor progress in order to verify progress); and (5) monitoring (to confirm short- and long-term effectiveness of cleanup and abatement).

Attachment B

Review Comments

by the Desert Research Institute on the

Technical Impracticability Evaluation

Early Final Remedial Action for Operable Unit 1

Leviathan Mine Site / Alpine County, California

Wood Environmental & Infrastructure Solutions, Inc.

September 20, 2021

DRI comments

Executive Summary

p. ES-1: OU-1 mine-influenced groundwater[1] exists primarily in unconsolidated materials and largely reports to the ground surface at five primary AD discharge locations:

DRI comment: per previous DRI comments, mine-influenced groundwater is assumed to only be within the mine area in unconsolidated materials, and that almost all of the mine-influenced groundwater is captured at current discharge locations. This assumption has not been adequately defined in the 2020 S.S. Papadopulos & Associates, Inc. Groundwater Report.

p. ES-1, footnote 1: [1] Mine-influenced groundwater is defined in the OU-1 FFS as groundwater with sulfate concentrations greater than 200 mg/L.

DRI comment: per previous DRI comments, sulfate concentrations greater than 200 milligrams per liter (mg/L) as the definition of mine-influenced groundwater appears to be too high a concentration.

p. ES-1: In contrast, groundwater flow in bedrock is minor relative to the flow in the overlying unconsolidated materials.

DRI comment: this idea has not been adequately defined in the Groundwater Report.

p. ES-2: ● The evaluation of groundwater remedial technologies consisting of attenuation, extraction wells, collection trenches, groundwater containment, and in situ groundwater treatment indicated these technologies would not be effective, are not implementable, and would be cost prohibitive at or near Leviathan Mine due to the complex hydrogeology and abundance of acid generating sulfide materials.

DRI comment: it is not clear that all of these technologies are not effective or implementable at the Leviathan Mine based upon the information presented in this TI evaluation.

p. ES-2: Groundwater TI Waivers Sought

Based on the demonstration of the technical impracticability of groundwater restoration described in this TI Evaluation, ARAR waivers for groundwater are sought for all ARARs identified in the OU-1 FFS. The spatial area for the proposed groundwater TI waiver is shown on Figure 6-1. This area encompasses the

entire area of mine-influenced groundwater delineated at or near Leviathan Mine and the remainder of the Leviathan Creek watershed.

DRI comment: requesting a TI waiver for the entire area shown in Figure 6-1 seems excessive. It is more appropriate to limit the area to the mine disturbed area and down gradient of the mine disturbed area.

p. ES-3: In addition, a TI waiver is sought to the extent required for SWRCB Resolution 92-49 Section III.G, because of the inherent difficulty in defining background concentrations at historic mine sites such as Leviathan Mine.

DRI comment: there should be sufficient data collected to define background concentrations at the Leviathan Mine.

p. ES-3: This TI evaluation demonstrates that no remedial technologies could feasibly attain ARARs for groundwater and discharges of treated effluent to surface water at the mine.

DRI comment: it is not clear that all of these technologies are not effective or implementable at the Leviathan Mine based upon the information presented in this TI evaluation.

Section 2.3 Characteristics and Extent of Mine-Influenced Groundwater

p. 7: In general, except where significantly altered near the pit by the mine workings, the permeability of the bedrock is significantly less than that of the overlying mine waste and native alluvium and colluvium. As a result, groundwater flow in bedrock is minor relative to the flow in the overlying unconsolidated materials.

DRI comment: per previous DRI comments, groundwater flow in the bedrock, mine contamination in the bedrock, and transport of mine contaminations by groundwater in the bedrock has not been adequately delineated.

p. 7: As a result of these net surface water and groundwater exchanges, groundwater chemistry beneath and adjacent to the creeks is influenced by surface water and vice versa. These exchanges of surface water and groundwater result in improvements to both surface water and groundwater quality during treated water discharges.

DRI comment: this is a new concept that was not directly described in the Papadopulos groundwater report. Additionally, the improvements in the groundwater quality, and the mechanisms for this improvement, were not provided.

p. 7: In locations where these unconsolidated materials pinch out on bedrock outcrops, the groundwater flow within these materials is forced to the surface and discharges directly to the creek due to the lower transmissivity of the bedrock (Figure 2-4) … This bedrock outcrop forces the groundwater flow in the unconsolidated materials upgradient of this location to discharge into Leviathan Creek as illustrated on Figure 2-4. This location represents the downgradient extent of site-related groundwater flow pathways from the mine to the downstream area.

DRI comment: per previous DRI comments, this statement assumes that there is no groundwater flow in the underlying bedrock and that groundwater in the underlying bedrock does not discharge to Leviathan Creek downgradient of the confluence with Aspen Creek. No groundwater flow in the bedrock has not been adequately delineated.

p. 7: The extent of mine-influenced groundwater at or near Leviathan Mine has been delineated based on sulfate concentrations greater than 200 milligrams per liter (mg/L) and groundwater flow directions, including preferential flow paths related to unconsolidated materials (S.S. Papadopulos, Inc. [SSPA], 2021).

DRI comment: per previous DRI comments, the 200 mg/L of sulfate cutoff appears to be higher than data suggest for mine-influenced groundwater in the bedrock.

p. 8: The extent of mine-influenced groundwater in bedrock is smaller than observed in the Unconsolidated System and is generally limited to areas beneath the pit and surrounding areas underlying mine waste, including the area underlying the upper portion of the LCBL (Figure 2-6).

DRI comment: per previous DRI comments, it has not been adequately demonstrated that the bedrock groundwater is not contaminated, and that bedrock groundwater does not flow off the site.

Section 2.4 Discharges to Surface Water and Effects on Surface Water Quality

p. 8: SSPA developed a water budget for the site and estimated that the implementation of year-round capture of the CUD and DS under the OU-1 EFRA would increase capture of mine-influenced groundwater, thereby reducing the volume of untreated groundwater flows to Leviathan Creek by approximately 20 percent (%) on annualized basis.

DRI comment: per previous DRI comments, the site water budget as described in the Papadopulos groundwater report is inadequate.

p. 8: Although uncertainties are inherent in any water budget estimate, the uncertainties here are small relative to the sizing of groundwater collection and conveyance systems and the proposed treatment-plant capacity. Consequently, the estimation of water fluxes at the site is considered adequate for EFRA design.

DRI comment: per previous DRI comments, the site water budget as described in the Papadopulos groundwater report is inadequate.

Section 3.0 Evaluation of Groundwater Restoration Potential

Section 3.1 Existing Data and Analysis

p. 10: In 2021, SSPA conducted an evaluation of groundwater conditions at and downgradient of the mine on behalf of Atlantic Richfield. SSPA documented their findings in a report which forms for the basis for the CSM summarized in Section 2.0 (SSPA, 2021).

DRI comment: This version of the Papadopulos groundwater report was reviewed by DRI and DRI provided detailed comments to the Water Board and USEPA. This version of the Papadopulos groundwater report does not address any of DRI's comments.

Section 3.2 Source Control Measures

p. 11: ● Mine-influenced groundwater is bounded vertically by lower permeability (unweathered) bedrock underlying the Unconsolidated System.

DRI comment: per previous DRI comments, groundwater flow in the bedrock, mine contamination in the bedrock, and transport of mine contaminations by groundwater in the bedrock is not adequately delineated.

Section 3.4 Demonstration that No Remedial Technologies Could Attain ARARs within Reasonable Timeframe

p. 11: Attenuation, extraction wells, collection trenches, groundwater containment, and in situ groundwater treatment would not be effective, are not implementable, and would be cost prohibitive at or near Leviathan Mine; therefore, these remedial technologies were eliminated from further consideration in the OU-1 FFS, resulting in a finding of technical impracticability for these technologies for the same reasons.

DRI comment: it is not clear that all of these technologies are not effective or implementable at the Leviathan Mine based upon the information presented in this TI evaluation.

p. 11 and 12: The evaluation of groundwater remedial technologies consisting of attenuation, extraction wells, collection trenches, groundwater containment, and in situ groundwater treatment indicated these technologies would not be effective, are not implementable, and would be cost prohibitive at Leviathan Mine due to the complex hydrogeology and abundance of acid generating sulfide materials.

DRI comment: it is not clear that all of these technologies are not effective or implementable at the Leviathan Mine based upon the information presented in this TI evaluation.

Section 4.2.1 Surface Water - Groundwater Exchanges

DRI comment: none for this section.

Section 6.0 Spatial Area over Which TI Waiver Will Apply

Section 6.1 Groundwater TI Zone

p. 24: The spatial area for the proposed groundwater TI waiver is shown on Figure 6-1.

DRI comment: requesting a TI waiver for the entire area shown in Figure 6-1 seems excessive. It is more appropriate to limit the area to the mine disturbed area and down gradient of the mine disturbed area.

Section 7.1 Groundwater Restoration Conclusions

p. 24: ● The evaluation of groundwater remedial technologies consisting of attenuation, extraction wells, collection trenches, groundwater containment, and in situ groundwater treatment indicated these technologies would not be effective, are not implementable, and would be cost prohibitive at or near Leviathan Mine due to the complex hydrogeology and abundance of acid generating sulfide materials.

DRI comment: it is not clear that all of these technologies are not effective or implementable at the Leviathan Mine based upon the information presented in this TI evaluation.

Table No. 3-1

p. 1: Attenuation. Not effective. Given the large amounts of sulfide-containing materials at the site and geochemical conditions that are conducive to the formation of AD, the source of chemical mass to

groundwater is essentially unlimited. As a result, groundwater quality at the site will continue to be influenced by AD in perpetuity.

DRI comment: Attenuation could be a viable treatment technique at the Leviathan Mine and should not be removed from further consideration. For example, trans-evaporative covers (for example http://www.nmcopperrules.com/mine-reclamation/#!) are a well-known treatment technique at mine sites to resist erosion, reduce stormwater infiltration, and support the indigenous flora and fauna. Soil covers can also reduce the amount of infiltration and groundwater recharge and eliminate oxygen thereby reducing the generation of acid drainage.

p. 2: Groundwater Containment. Not effective. Effective construction of a deep, continuous subsurface barrier to isolate all subsurface mineralized material would be extremely challenging at the site. Construction quality control to verify integrity of containment would be extremely difficult.

DRI comment: Groundwater containment could be a viable treatment technique at select locations at the Leviathan Mine and should not be removed from further consideration. For example, a subsurface barrier wall at the Delta Seep could be used to contain the acid drainage flowing below the toe of the seep that is not currently being captured by the existing capture system.

Figure 2-2

DRI comment: the figure as drawn indicates groundwater flow in the unweathered bedrock. This is not consistent with the FFS in that the FFS assumes that there is minimal groundwater flow in the unweathered bedrock, there is no mine contamination in the unweathered bedrock, and that groundwater in the unweathered bedrock does not flow off site. However, this has not been adequately delineated in the Papadopulos groundwater report.

Figure 2-3

DRI comment: the figure as drawn indicates groundwater flow in the unweathered bedrock. This is not consistent with the FFS in that the FFS assumes that there is minimal groundwater flow in the unweathered bedrock, there is no mine contamination in the unweathered bedrock, and that groundwater in the unweathered bedrock does not flow off site. However, this has not been adequately delineated in the Papadopulos groundwater report.

DRI comment: the figure uses the term “Regional Groundwater Flow”, per previous DRI comments, the term should not be used to describe groundwater flow in the unweathered bedrock and is not consistent with aquifer definitions in the Groundwater TDSR, Atlantic Richfield, 2017c, Groundwater Technical Data Summary Report, Appendix B of Site Characterization Report, Leviathan Mine Site, Alpine County, California. Prepared by Amec Foster Wheeler Environment & Infrastructure, Inc., December 22.

Figure 2-4

DRI comment: the figure as drawn indicates groundwater flow in the unweathered bedrock. This is not consistent with the FFS in that the FFS assumes that there is minimal groundwater flow in the unweathered bedrock, there is no mine contamination in the unweathered bedrock, and that groundwater in the unweathered bedrock does not flow off site. However, this has not been adequately delineated in the Papadopulos groundwater report.

Figure 2-6

DRI comment: in this figure, the extent of mine-influenced groundwater in the bedrock is defined by the 200 mg/L sulfate concentration criterion. Per previous DRI comments, the 200 mg/L of sulfate cutoff appears to be higher than data suggest for mine-influenced groundwater in the bedrock. Per previous DRI comments, it has not been adequately demonstrated that the bedrock groundwater is not contaminated, that the lateral extent of the mine-influenced groundwater in the bedrock is greater than depicted, and that contaminated bedrock groundwater does not flow off the site.

Attachment C

Review Comments

by the Desert Research Institute on

Section 3.3 Groundwater Restoration Timeframe Analysis

Technical Impracticability Evaluation

Early Final Remedial Action for Operable Unit 1

Leviathan Mine Site / Alpine County, California

Wood Environmental & Infrastructure Solutions, Inc.

September 20, 2021

DRI comments

Section 3.3 Groundwater Restoration Timeframe Analysis

Two approaches are used to estimate time to depletion of the ore body and mine waste. The zero-order approximation is a mass-balance approach that assumes pyrite weathers at a constant rate. The second approach considers the more realistic behavior that weathering rate occurs as a function of the number moles present at a given instance in time. The zero-order approach is valid within approximately an order of magnitude but is best used to estimate the time scale of pyrite depletion in the first-order method, whose inverse is the decay rate constant.

The approaches do not consider variability in the input data. For the calculations, various input values such as volume and mass of mine waste, volume and mass of the ore body and halo, rock density, pyritic sulfur volume, mean sulfate concentration, and acid drainage flux are presented as fixed values. However, all these input values have uncertainty that can be estimated and included in the calculations to provide a range in years for both the zero-order and first-order approximations.

For example, if the input values for mass, volume, and pyrite mass for the mine waste and the ore body were varied by 10 percent, the range for the zero-order approximation would be 3,323 ± 332 years, and if by 50 percent the range would be 3,323 ± 1661 years. For the first-order approximation, 10 percent variation in input values produced 15,305 ± 1,530 years and for 50 percent variation 15,305 ± 7,651 years (spreadsheet of calculations attached). An appropriate error propagation technique should be used when varying all the input values.

The “groundwater restoration timeframe analysis” using the zero-order and first-order approximations described by Younger et al. (2002) should be recalculated considering variability in the input values based upon the data used to generate the input values. It is also important to note that the times produced by the zero-order and first-order approximations do not define the range in times as stated, “The zero-order approximation of over 3,300 years and the first-order approximation of more than 15,000 years represents an approximate range of time that pyrite in source materials would be expected to act as a contamination source to groundwater at the mine.” Rather, for a given approximation calculation, the range in time is defined by the variability of the input data. Two different methods just

give two different times, and these times do not define the approximate range in time for the pyrite depletion at the site.

We did not look at other methods to calculate a “groundwater restoration timeframe” and we did not critically evaluate the methods presented by Younger et al. (2002).

Appendix A

The full reference for “BC (1983)” is not included.

More description and/or references for input values such as vol % pyritic sulfur for the mine waste, wt % for the ore body, and pyrite density are needed.

More description is needed for how the mean sulfate concentration was determined. For example, what sample locations and which years were used. How were drought vs. record precipitation years used?

More description is needed for how the mean acid drainage flux was determined. For example, what monitoring locations and which years were used. How were drought vs. record precipitation years used?