AF Responses to Proposed EBR Pilot Study

EPA/ADEQ proposed path forward components	AF Response
Evaluate viability of EBR as a treatment technology and determine optimal conditions for EBR.	Multiple lines of evidence for existing biodegradation already exist. Biodegradation is occurring at the site but is limited by the availability of electron acceptors (e.g., sulfate).
Conduct a pilot study prior to full scale EBR implementation.	Implementation of full scale EBR phased remediation provides the equivalent, and more, data as that of an EBR pilot study. The AF full-scale phased implementation has the flexibility of adjusting locations and/or initial sulfate injections to allow confirmation of enhancement.
Six areas proposed, two in each zone for a pilot study.	Limited site remediation will occur during the approximate two year period of the pilot study. During full scale implementation, the entire site will be treated and comprehensive data will be evaluated. Approximately thirty areas will be treated in the first six months, starting with up-gradient and plume core areas.
Verify degradation of LNAPL by testing area of high LNAPL concentration	a) Regulators are in agreement with the AF approach to remove LNAPL accumulation in several known areas before implementation of EBR. EBR monitoring data will assess the degradation/transformation of LNAPL with the emphasis on the potential flux of benzene into groundwater. b) The primary objective of EBR as presented in the approved RD/RAWP is to reduce chemicals of concern in groundwater to acceptable levels that will result in meeting remedial action objectives twenty years post RODA. Verifying degradation of LNAPL in high LNAPL areas would likely not be conclusive in predicting timeframes for remediation in LNAPL areas. There are technical challenges associated with this type of evaluation including the location and quantity of LNAPL present, location and distribution of sulfate relative to LNAPL locations, flux of groundwater and LNAPL, migration of LNAPL from adjacent areas, diffusion from lower-permeability lenses, etc. c) Realistic expectations for evaluation in areas of LNAPL would be demonstration that biodegradation is occurring, that mobile LNAPL is diminished and that sulfate depletion with sustained or reduced groundwater benzene concentrations indicates that LNAPL dissolution is occurring.

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Include recirculation to validate modelling done to predict remedial time frame.	The objective of continuous recirculation presented in RD/RAWP was TEA distribution. The remedial timeframe in the RD/RAWP modeling is dependent on sufficient TEA and benzene degradation rates rather than the groundwater flow pattern. Limited recirculation was evaluated in Addendum 2 and will achieve a similar TEA distribution, although continuous recirculation may be utilized in specific areas. Continuous or limited recirculation does not significantly impact degradation rates. The degradation rate used in the RD/RAWP model is not dependent on the type of recirculation.
Other lines of evidence to demonstrate that EBR is working as expected would include geochemical and microbiological analyses to determine the response of site geochemistry and the microbiota (particularly those microorganism groups known to be involved in degradation of benzene under sulfate-reducing conditions) to sulfate injection.	Included in Addendum 2 full scale implementation.
Data collected before and during implementation of EBR would be used to evaluate its efficacy, would be the basis for optimizing the system as appropriate, and would provide data on benzene degradation rates to be incorporated into appropriate models to predict the time to remediation.	Included in Addendum 2 full scale implementation. Current implementation approach (has multiple phases) is iterative and will include data collection, optimization and adjustments as requested by the regulatory agencies.
Verify that benzene (including benzene in the LNAPL phase) is being degraded/depleted, to verify effective TEA distribution throughout the treatment area. Measure of effectiveness of EBR would be reduction of benzene concentrations in LNAPL and groundwater, after allowing for the potential increase in dissolved phase concentrations immediately after the TEA is injected.	Monitoring dissolved phase benzene reduction in groundwater is a primary objective and is included in Addendum 2 full scale EBR implementation. Demonstration of benzene reduction in LNAPL is as noted above is technically challenging and will be measured indirectly as benzene concentrations in groundwater, sulfate depletion in groundwater, diminishing mobile LNAPL, and presence of bio-emulsions and other visual indicators of biodegradation.